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# Computer Program for Estimating Performance of Air-Breathing Aircraft Engines

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## Contents

Summary . . . . .	1
Introduction . . . . .	1
Symbols and Abbreviations . . . . .	2
QNEP Description . . . . .	2
Configuration Layout . . . . .	3
Engine Configuration . . . . .	3
Configuration Data . . . . .	3
Component Data . . . . .	4
Table Data Decks . . . . .	4
Controls . . . . .	5
Control Assignment . . . . .	5
Reliability . . . . .	6
Accuracy . . . . .	6
Limitations . . . . .	6
Operation of QDATGEN . . . . .	6
User-Specified Configuration . . . . .	11
Modifying an Existing NAMELIST Input . . . . .	11
Modifying an Existing Configuration . . . . .	11
Off-Design Point Input . . . . .	12
Concluding Remarks . . . . .	13
Appendix A—QNEP Users Guide . . . . .	14
QNEP Description and Limitations . . . . .	14
Input Data . . . . .	17
JFIG(I,J)—Configuration Data Input . . . . .	18
Component Code 1—Inlet . . . . .	23
Component Code 2—Duct, Burner, or Afterburner . . . . .	24
Component Code 4—Compressor . . . . .	26
Component Code 5—Turbine . . . . .	28
Component Code 6—Heat Exchanger . . . . .	30
Component Code 7—Splitter . . . . .	32
Component Code 8—Mixer . . . . .	33
Component Code 9—Nozzle . . . . .	33
Component Code 10—Load . . . . .	34
Component Code 11—Shaft . . . . .	36
Component Code 12—Control . . . . .	37
Component Code 13—Optimization . . . . .	38
Component Code 14—Limit . . . . .	39
QNEP Output . . . . .	39
Appendix B—Existing Configurations in Engine Data Base . . . . .	41
Dual-Rotor Turbofan—Default Configuration 1 . . . . .	41
Dual-Rotor Turbofan—Default Configuration 2 . . . . .	43
Dual-Rotor Turbofan—Default Configuration 3 . . . . .	45
Dual-Rotor Turbojet—Default Configuration 4 . . . . .	47

Single-Shaft Turbojet—Default Configuration	47
Dual-Rotor Turbofan—Default Configuration	50
Ramjet—Default Configuration	52
Appendix C—QNEP and QDATGEN Options and Sample Problems	53
Command Line Options	53
Sample Problem 1—User-Specified Configuration	56
QDATGEN Terminal Session	56
QNEP Terminal Session	73
Sample Problem 2—Modifying an Existing NAMELIST Input	92
QDATGEN Terminal Session	92
QNEP Terminal Session	100
Sample Problem 3—Modifying an Existing Configuration	109
QDATGEN Terminal Session	109
QNEP Terminal Session	118
References	128

## Summary

QNEP is a reliable, easy-to-use computer program for predicting the design point and off-design steady-state performance for a variety of air-breathing aircraft engines. These include gas turbines with single or multiple spools, multiple flow paths, and multiple exhaust nozzles as well as ramjets. QNEP is a modified version of the Navy Engine Performance Computer Program (NEPCOMP). NEPCOMP and its successor, the Navy-NASA Engine Program (NNEP), have broad capabilities including optimization, chemical equilibrium gas calculations, and engine control variations. Hence, they are necessarily complex, with large computer memory requirements. QNEP was developed to be used for conceptual and preliminary design studies where the broad capability, the attendant complexity, and the large memory are not necessary. QNEP is small enough to be run on a personal computer with 640 kilobytes of memory. It first sizes the engine for a selected design point mass-flow rate. It can then be set to run a series of off-design cases as specified in the input file, or it can be used to interactively select points where off-design performance data are to be computed. QNEP reliably computes performance parameters that agree with existing data for a variety of engines. A companion preprocessor program called QDATGEN was developed to aid inexperienced users of QNEP. It is used to interactively generate input files. QDATGEN contains a data base of seven engine configurations from which the user can choose. It includes two unducted turbofans, two ducted turbofans, two turbojets, and a ramjet. The user can also enter a new configuration or modify an existing configuration. The small size of QNEP should appeal to a wide range of users, including small companies or research organizations and especially students. It has the potential to be directly linked to other computer programs (e.g., mission, weight, cost, or noise analyses) that require propulsion performance data or aircraft engine thermodynamic cycle data. This report gives a detailed description of QNEP, including its input, accuracy, reliability, and limitations. It also contains a description of QDATGEN, sample calculations, and a users guide.

## Introduction

There are many gas turbine analysis codes capable of generating performance data for use in preliminary airframe design and engine-airframe integration studies. One program widely employed for these purposes is NEPCOMP, the Navy Engine Performance Computer Program (ref. 1). A recently modified version of the Navy-NASA Engine Program (NNEP,

ref. 2), a derivative of NEPCOMP, has additional capabilities for handling optimization, chemical equilibrium gas calculations, and varying engine control characteristics. Other available programs (refs. 3, 4, and 5) are restricted to turbojets and turbofans. Most of the existing programs are quite complex and have memory requirements that restrict their use to mainframes and minicomputers. There is a need for a simpler yet reliable and accurate method for rapidly predicting design point and off-design steady-state performance parameters for a variety of aircraft engines. The method should be easy to use for preliminary analyses of advanced propulsion systems and in engine-airframe integration studies. While it is necessary to retain the capability to model a variety of engine cycles, many of the capabilities found in the latest versions of NNEP (which contribute to its size and complexity) are unnecessary for the kinds of preliminary studies of interest.

The purpose of this report is to describe a modified version of NEPCOMP called Quick NEP (QNEP), which meets the current need. QNEP does not contain the special capabilities of NNEP as previously described and is therefore smaller and relatively easy to use. It is capable, however, of predicting design point and off-design steady-state performance parameters for a variety of aircraft engines. QNEP allows for a wide variety of compressor and turbine maps, flow scheduling, and a variety of other off-design functional relationships. Because the component maps are scaled by QNEP, parametric variations of the design point characteristics can yield realistic results for off-design cases without the need to change the component maps. Most importantly, because it is small, QNEP can be run on a personal computer having 640 kilobytes of memory. It has the additional potential for being linked directly to other computer programs (e.g., mission analyses, engine weights, engine costs, and noise) that require propulsion performance data or aircraft engine thermodynamic cycle data.

This report contains a complete description of QNEP, sample calculations, and an evaluation of the accuracy and reliability of the program. A "QNEP Users Guide" is included as appendix A. This report also includes a description of a preprocessor program called QDATGEN, which was written to assist casual and novice users of QNEP. QDATGEN can be used to modify existing input files or to create new input files based on a user-defined configuration or one of seven configurations contained in its data base. The seven configurations include two unducted turbofans, two ducted turbofans, two turbojets, and a ramjet.

## Symbols and Abbreviations

<i>A</i>	area, in <sup>2</sup> or ft <sup>2</sup>	2	component exit; compressor entrance and inlet exit
AB	afterburner	ref	reference
AIA	Aircraft Industries Association	<i>s</i>	static
CDAT	component data input, a two-dimensional array used to define component characteristics and design point parameters	<i>t</i>	total
<i>D</i>	drag, lb		
DATOUT	component data output, a two-dimensional array used to define component output data		
JFIG	configuration data input, a two-dimensional integer array used to define the engine to be modeled		
<i>N</i>	rotational speed, rpm		
NP	number of throttle setting points to be computed		
OPR	overall pressure ratio		
<i>P</i>	pressure, lb/in <sup>2</sup> or lb/ft <sup>2</sup>		
PR	pressure ratio		
<i>q</i>	dynamic pressure, lb/ft <sup>2</sup>		
<i>R</i> -value	one of two (three for stacked maps) parameters used to define a point on a compressor map		
SF	scale factor		
SFC	specific fuel consumption, (lb/hr)/lbf		
<i>T</i>	temperature, °R		
TDEL	decrement in burner outlet temperature		
vgp	variable geometry parameter		
<i>W</i>	mass flow, lb/sec or lb/hr		
WMAX	scalar multiplier of maximum referred flow		
Δ	increment		
δ	corrected pressure, $P/14.696$		
θ	corrected temperature, $T/518.67$		
Subscripts:			
0	free stream		
1	component entrance; inlet entrance		

## QNEP Description

QNEP, a special version of NEPCOMP, the Navy Engine Performance Computer Program, is capable of simulating the thermodynamic cycle performance for a variety of air-breathing aircraft engines. The flow-through components (inlets, compressors, splitters, etc.) and the mechanical components (shafts and loads) are interconnected by the user as needed to simulate the configuration of interest. Flow station numbers are assigned at the entrance and exit of each flow-through component in the configuration. At each flow station, beginning with each inlet, QNEP computes the gas thermodynamic properties and the weight-flow rate. In a converged solution, continuity is satisfied, total shaft horsepower is balanced, and, in mixer components, the static pressures of the two flow streams are equal at the mixing plane. These criteria are satisfied by a third category of components called *controls*. Controls link dependent and independent variables. The dependent variables are errors, and when these errors become small the solution convergence criteria are satisfied. The concept of "errors" and controls is discussed in greater detail in a subsequent section of this report.

The code assembles the configuration through an integer array (the JFIG array) entered in NAMELIST<sup>1</sup> format. The array has the dimensions of 5 times the number of components (up to a maximum of 40) in the configuration being simulated. The first of the five integers associated with each component indicates the component type (such as ducts, compressors, turbines, and nozzles) and the remaining four signify flow stations entering and leaving the component or components connected to a shaft. A data array, with dimensions of 15 times the number of components (the CDAT array), provides details about the particular component (such as efficiencies and pressure ratios or table reference numbers, design point characteristics, scale factors, and drag coefficients). Table data decks can be used to define compressor or turbine maps, inlet and nozzle drag coefficients, and other functional relationships.

<sup>1</sup> It should be noted that NAMELIST is an extension to the Fortran 77 standard and may not be available with all Fortran compilers.

With the configuration and the configuration data, QNEP proceeds with the design point solution. At the design point continuity is automatically satisfied by assigning the appropriate flow area, and any shaft horsepower imbalance is satisfied by the appropriate turbine pressure ratio. Control components are not required at the design point. When component maps are used, the design point operating conditions are located on the maps and scale factors are computed to match the map result with the requested design point characteristic. These scale factors are then used to scale the maps during off-design operation. After the design point is complete, solutions to any off-design cases are found through an iterative approach. A control component is assigned to link a dependent variable, generally an error, to an independent variable, which is then varied until the dependent variable attains the desired value. Control components are required wherever an error is present. After a preliminary pass through the configuration to establish a base, QNEP begins the process by perturbing the independent variables, thereby generating a matrix of approximate partial derivatives. With the derivatives a set of linearized equations can be written, which QNEP solves using a modified Newton-Raphson method. A more detailed description of the solution convergence technique can be found in reference 1.

QNEP output depends on the level of detail requested. At the very least, propulsion performance data, including thrust, fuel flow, specific fuel consumption, and burner outlet temperature, is printed for each case. If requested, weight flow, total pressure, total temperature, fuel-to-air ratio, and referred flow are printed at each flow station, along with data specific to each component for each point. Appendix A contains a detailed description of QNEP input and output.

## Configuration Layout

The engine configuration to be studied is constructed by laying out and numbering the core flow components in order beginning, in general, with an inlet and ending, in general, with a nozzle. Flow stations are numbered consecutively, beginning with "1" the flow stream entering the inlet as number 1. This procedure is repeated for the secondary flow path (where the component and flow station numbering is a continuation of the core flow numbering) and usually begins at a splitter component and ends with a mixer or nozzle component. Any other flow paths (e.g., bleed and cooling flows) are numbered consecutively beginning at the first downstream com-

ponent where such a flow exists. Except where a heat exchanger is involved, flow cannot pass from a downstream component to an upstream component. For heat exchangers, the same mass flow can pass through the heat exchanger component twice, first as the cold stream and then as the hot stream. Once all flow-through components have been established, mechanical components are defined as necessary. Shafts can connect to compressors, turbines, loads, and other shafts. Each shaft can connect to a maximum of four components. The high-pressure rotor is established by defining the farthest downstream compressor as connected component number 1, the next compressor as number 2, etc. The next connected component is the turbine, which drives the compressor(s). A load may be defined as the final connected component. This procedure is repeated for the low-pressure rotor as necessary. In some instances, a turbine may be connected only to a load, in which case the shaft will have two connected components, the turbine and the load. Finally control components are defined for each nozzle, mixer, turbine, compressor, shaft, and heat exchanger in the configuration. Appendix B contains several examples of common configurations and control assignments.

## Engine Configuration

### Configuration Data

The configuration data (JFIG) array describes the basic configuration of the engine to be simulated. JFIG has dimensions of five times the number of components (including controls) in the engine. The first subscript in the array can vary from 1 to 5 and the second varies from 1 to the total number of components in the configuration, and in fact designates the component number. Thus, each component has five integer values associated with it. The first element is the component based on the codes identified in table A1. For flow-through components, the second and third elements indicate flow station numbers where flow enters the component for primary and secondary flows, respectively. Similarly, the fourth and fifth elements indicate flow stations where flow leaves the component. Detailed definitions for these elements, for all component types, are given in appendix A. Where no definition is given, that element is either set to zero or left blank.

Example:  $JFIG(I,5)=4,5,0,6,20$ ;  $I=1,5$  indicates that component 5 is a compressor (code=4), that the primary flow stream enters at station 5 and leaves at station 6, and that bleed flow

leaves the compressor at station 20. There is no secondary inlet flow allowed for compressor components ( $JFIG(3,5)=0$ ).

### Component Data

The data that describe the basic component characteristics and design point parameters are contained in the two-dimensional CDAT array. The second element in the CDAT array, as with the JFIG array, corresponds to the number of the component being defined. The first element varies from 1 to 15 and corresponds to the definitions in appendix A. These definitions depend on the component type as defined by JFIG1 of the JFIG array. The CDAT array generally defines such items as design point parameters, table reference numbers, efficiencies, and control variables. Some elements of the array are calculated during the design point run of QNEP based on the value at the location where the map is entered. For example, at the design point, compressor pressure ratio, efficiency, speed, and  $R$ -value are all specified. Lines of constant  $R$ -value are drawn on the compressor map, approximately parallel to the surge line, to avoid the possibility of having two values of corrected mass flow at a given pressure ratio and corrected speed. Given an  $R$ -value and a corrected speed, QNEP can locate a unique position on the compressor map. If there are no compressor maps, the scalar multipliers on pressure ratio and efficiency will remain equal to the entered value (usually 1). If maps are available, then scalar multipliers are computed based on the result at the speed and  $R$ -value specified.

### Table Data Decks

Table data decks can be used to provide detailed characteristics of many of the components, including variable geometry characteristics and installation effects. Table I gives a list of components and their possible tables. Graphical representations of these tables are given in appendix A. The referred flow schedule is the only required table in QNEP. This table along with WMAX, a scalar multiplier of the table value, defines the maximum referred flow allowed to enter the engine as a function of altitude and  $\theta_{t,2}$ . The corrected temperature at the compressor face  $\theta_{t,2}$  is defined as the total temperature in °R at station 2 divided by 518.67. Referred flow is reduced to this maximum by reducing the burner outlet temperature when necessary. If a map of compressor weight flow is available, the flow schedule must still be included; but WMAX can be large so that the engine characteristics are based entirely on the compressor maps. Because tabular data are extrapolated by QNEP, WMAX can also be used to limit

Table I. Possible Data Tables

Component	Possible table
Inlet	$D/qA$ vs $A_0/A_{ref}$ or referred flow for various Mach numbers Inlet recovery vs referred flow for various Mach numbers
Duct	$\Delta P/P$ vs corrected flow
Burner	$\Delta P/P$ vs corrected flow Efficiency vs corrected flow for various fuel-to-air ratios Fuel heating value vs burner outlet temperature for various inlet pressures
Compressor	Referred flow vs $R$ -value for various referred speeds Efficiency vs $R$ -value and referred speed PR vs $R$ -value and referred speed
Turbine	Referred flow vs PR for various referred speeds Efficiency vs PR and referred speed
Heat exchanger	$\Delta P/P$ vs corrected flow (primary stream) $\Delta P/P$ vs corrected flow (secondary) Effectiveness vs cold side mass flow for various hot-to-cold mass-flow ratios
Splitter	$\Delta P/P$ vs corrected flow (primary stream) $\Delta P/P$ vs corrected flow (secondary)
Nozzle	Nozzle flow coefficient vs PR (total to ambient) Aft end $D/qA$ vs PR for various Mach numbers or aft end $D/qA$ vs Mach number for various exit-to-design-point throat area ratios Thrust coefficient vs PR for various exit-to-design-point throat area ratios Exit-to-design-point throat area ratio vs throat-to-design-point throat area ratio
Load	Load power vs load rotational speed

the compressor speed to some reasonable value. In this case, the burner outlet temperature is reduced so that WMAX is not exceeded. The maximum referred flow schedule can also be used to limit the maximum available airflow based on a fixed inlet capture area. Table data decks are included in the input file immediately following the design point NAMELIST

input and title card and are formatted as shown in figure A2. The maximum table size is 30 000 values.

## Controls

At each operating point (Mach number, altitude, and throttle setting), conservation of mass and energy must be maintained. In addition, all rotating machinery must rotate at distinct speeds. In order to achieve these conditions, or “match” the engine, controls are a necessary part of the overall input for any engine configuration to be run in the off-design mode. Controls are used to connect dependent and independent variables in the generation of an error matrix necessary to determine solution convergence. The independent variables are varied until the corresponding dependent variables achieve the desired values. For off-design runs of QNEP, the dependent variables are generally errors and a solution is found (the engine is “matched”) when their values become small. Interface relative flow errors, the relative difference between the mass flow at a given flow station and the mass flow that the component downstream of that flow station will pass, exist upstream of each nozzle, turbine, and compressor in the engine being modeled. At each mixer, the static pressures of the core stream and of the bypass stream must be equal, and heat exchangers require that energy be conserved by selection of the appropriate main exit flow stream temperature. The horsepower generated by a turbine (or turbines) is balanced against the horsepower required by compressors and loads by assuring that the net shaft horsepower is zero. Typically these errors are eliminated by varying one or more of the following: airflow for inlets;  $R$ -value, pressure ratio, and/or variable geometry parameter for compressors; pressure ratio and/or variable geometry parameter for turbines; throat area for nozzles; bypass ratios for splitters; rotational speed for shafts; horsepower for loads; and temperature rise for heat exchangers.

In the NAMELIST containing the design point input data, no controls are required. Controls may be assigned at the design point to achieve a desired net thrust, specific fuel consumption, fuel flow, etc. Generally all controls are assigned in the first NAMELIST input. Any control assigned in the first NAMELIST input remains in effect unless it is turned off. The initial status (*on* or *off*) of these controls is as specified by the first element in the CDAT array (CDAT1) for the control component. After the design point has been run all controls become active, and any controls not required by the next run must be turned off by setting CDAT1 equal to zero.

Table II. List of Component Types and Associated Errors

Component type	Error
Nozzle	Interface relative flow error at the upstream flow station
Turbine	Interface relative flow error at the upstream flow station
Compressor	Interface relative flow error at the upstream flow station
Mixer	Mixer static-pressure balance relative error
Shaft	Net shaft horsepower divided by average shaft horsepower
Heat exchanger	Relative temperature rise error

## Control Assignment

Controls must be defined, in any engine configuration, for each of the components listed in table II for any off-design run. Starting at the component farthest downstream, usually a nozzle, the user moves through the core of the configuration assigning a control at each flow station or component containing an error. (See table II.) These controls zero out the errors by varying one of the CDAT input data variables of upstream components. The upstream component containing the independent variable is generally the next closest component at or ahead of which an error exists. The error at the flow station or component just downstream of the inlet is generally eliminated by varying the inlet mass-flow rate. This procedure is repeated for the secondary flow path. In this approach, mixers are considered to be in the secondary flow. For the secondary flow, the error is generally associated with a mixer or a nozzle and is eliminated by varying the bypass ratio at the splitter (unless one of the six components listed in table II lies between the splitter and the mixer). Next, controls are assigned at each shaft. The shaft horsepower usually is balanced by varying the rotational speed of the shaft or the corrected mass flow of a connected compressor component. The independent variables used to eliminate these errors must be from the CDAT input variables. The choice of which CDAT input variable is used depends, in general, on the table data decks used for the rotating machinery. For example, a compressor being modeled by a complete set

of data requires two inputs to define the operating point. Generally the  $R$ -value<sup>2</sup> and the shaft rotational speed are varied to eliminate two of the errors. If the table data deck gives pressure ratio and efficiency as a function of speed only and the  $R$ -value is constant, then some other CDAT input variable must be used, such as referred flow. Two active controls must never use the same CDAT input variable of the same component as an independent variable. (See examples in appendix B.)

## Reliability

The reliability of QNEP depends directly on the complexity of the configuration. In general, the ducted turbofan is somewhat less reliable than the unducted turbofan, and both are less reliable than the turbojet or the ramjet. Because QNEP uses the results of the preceding case for the initial guess in the current case, large variations in the input may prevent convergence or may even cause the program to abort. Large gradients in the table data decks used to describe compressors, turbines, and other engine characteristics may also cause the program to abort. The iteration required to reduce the burner outlet temperature to an acceptable level, based on the referred flow schedule and WMAX, is somewhat unstable for poor initial guesses. Therefore, while a large value of WMAX generally improves reliability, it may result in overspeeding the compressor or the turbine. If WMAX is selected to avoid overspeeding, the maximum turbine inlet temperature may, in some instances, have to be reduced manually in order for QNEP to converge. Generally, however, QNEP will converge to a solution in well under 50 iterations and usually in 3 to 10 iterations. The farther the initial guess is from the solution, the more iterations are required, as may be the case where a low Mach number, high-throttle point follows a high Mach number, low-throttle point. In most instances when QNEP fails to converge, the input is either erroneous or unrealistic. In these instances, special attention should be paid to the component maps. For example, as Mach number is increased, the compressor generally matches at a lower corrected speed  $N/\sqrt{\theta}$ , where the pressure ratio and mass flow do not vary as much as they do at the higher corrected speeds. This compressor operating condition may eventually erode to a point where there is no change in one of the dependent variables

<sup>2</sup> The combination of  $R$ -value and rotational speed (and the variable geometry parameter for stacked maps) defines an exact location on a compressor map. Figures 1 and 2 show plots of the compressor maps used in the default tables. The  $R$ -values of 1 (the surge line) and 2 (near the minimum loss line) are plotted. In the default tables the  $R$ -value ranges from 1 to 3.

for a finite change in the independent variable. A solution in this case is to design the engine for the higher Mach number at a reasonable corrected speed and then throttle the engine back at the lower Mach numbers to prevent overspeeding of the compressor. Experience and a detailed examination of the output should resolve most of the problems encountered.

## Accuracy

The accuracy of QNEP was verified by simulating three different engines: the TF34-GE-(AWACS) high-bypass-ratio unducted turbofan, the TF30-P-100 low-bypass-ratio ducted turbofan, and the J79-GE-17 single-shaft turbojet. Table data decks for all compressors and turbines were developed using CMGEN, PART, and MODFAN (refs. 6 to 8). Limited engine cycle descriptions (ref. 9) were used to generate the QNEP input files. Because the available data are limited, rough agreement was obtained by varying bleed flows, efficiencies, and map locations (speed,  $R$ -value, etc.) at the design point. The results shown in figures 3 to 7 were then obtained by varying bleed flows, variable geometry parameters (where applicable), afterburner efficiency (for the afterburning modes of operation), and turbine inlet temperature at each altitude and Mach number. Figures 3 to 7 demonstrate the accuracy of QNEP for the three engine bypass ratios for Mach numbers from 0 to 2.4.

## Limitations

QNEP is capable of simulating nearly any conceivable air-breathing configuration with not more than 40 components, including controls. The limit of 40 components is a function of array size. It is large enough to allow the simulation of most realistic engines and small enough to run on a personal computer. QNEP has no optimization procedure, and therefore is not as well suited to variable-cycle engine studies as NEPCOMP or NNEP. Neither does it have the capability (as does NNEP) to perform chemical equilibrium gas calculations or to vary engine control characteristics. The kind of control variations available in NNEP can only be achieved in QNEP by observing the output and manually changing the control or control settings.

## Operation of QDATGEN

A preprocessor program called QDATGEN was written to assist casual and novice users of QNEP. The program should allow the user to create a QNEP input file without having to refer to the users guide presented in appendix A. QDATGEN, written in

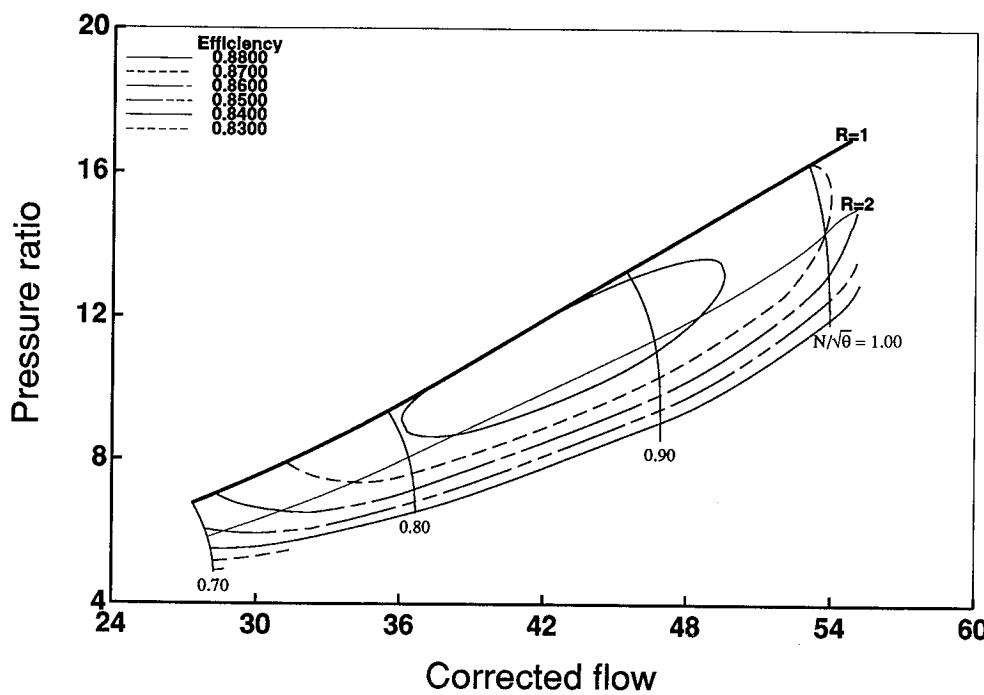


Figure 1. Default compressor map for  $v_{gp} = 0$ .

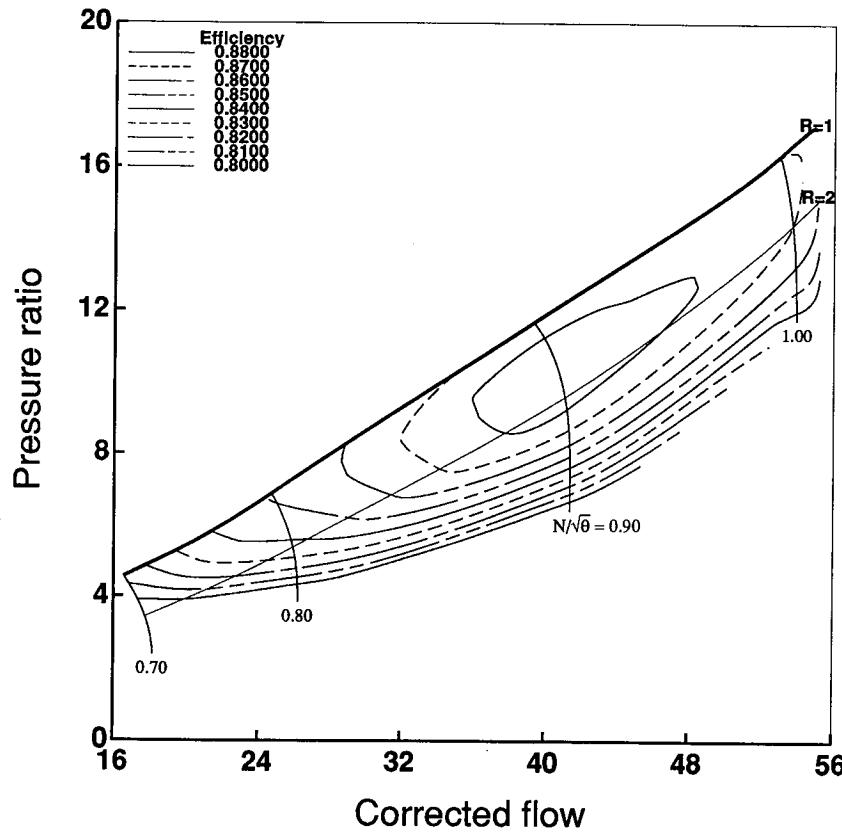


Figure 2. Default compressor map for  $v_{gp} = 90$ .

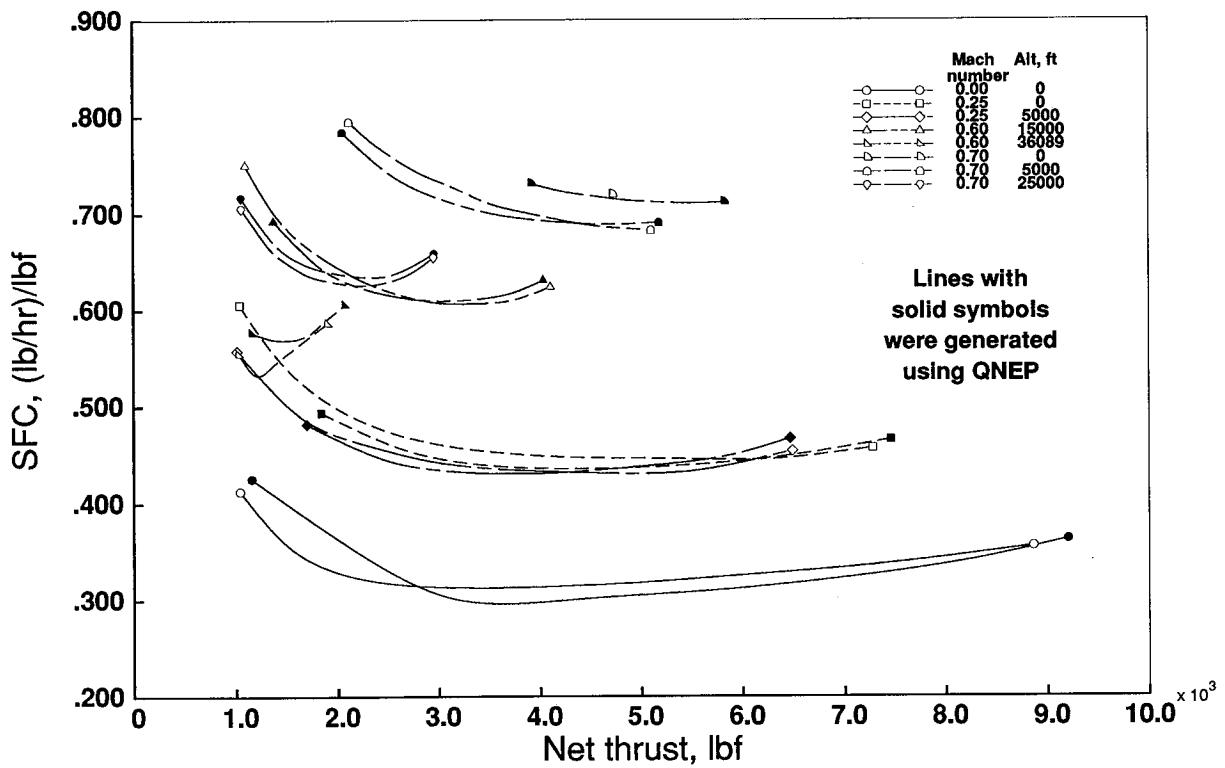


Figure 3. Accuracy of QNEP vs actual data for TF34-GE-(AWACS) engine.

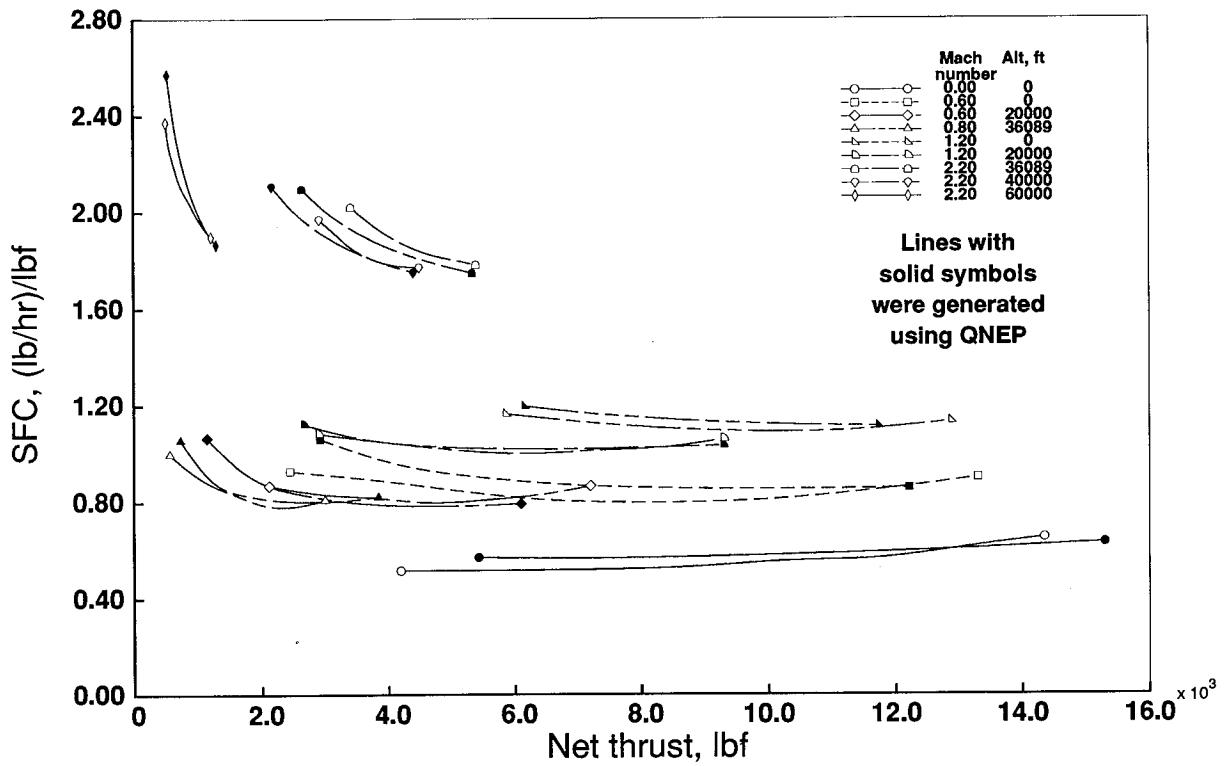


Figure 4. Accuracy of QNEP vs actual data for TF30-P-100 engine with afterburner off.

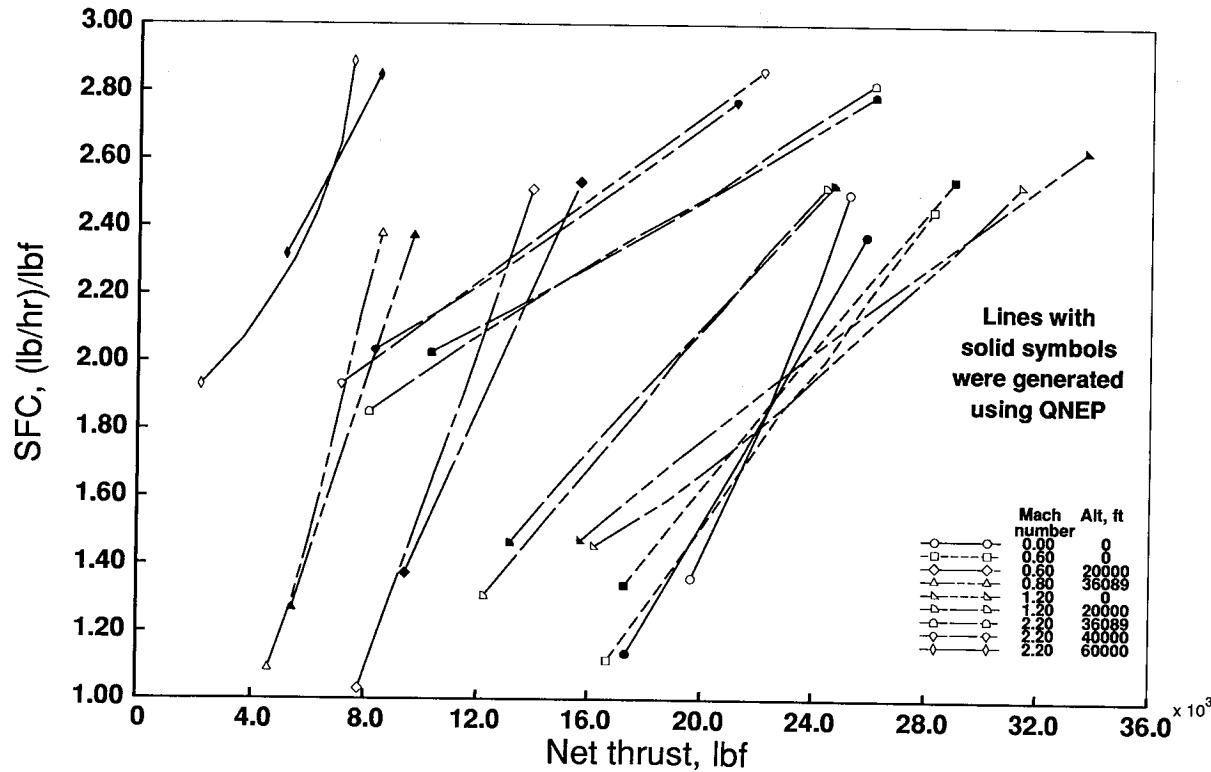


Figure 5. Accuracy of QNEP vs actual data for TF30-P-100 engine with afterburner on.

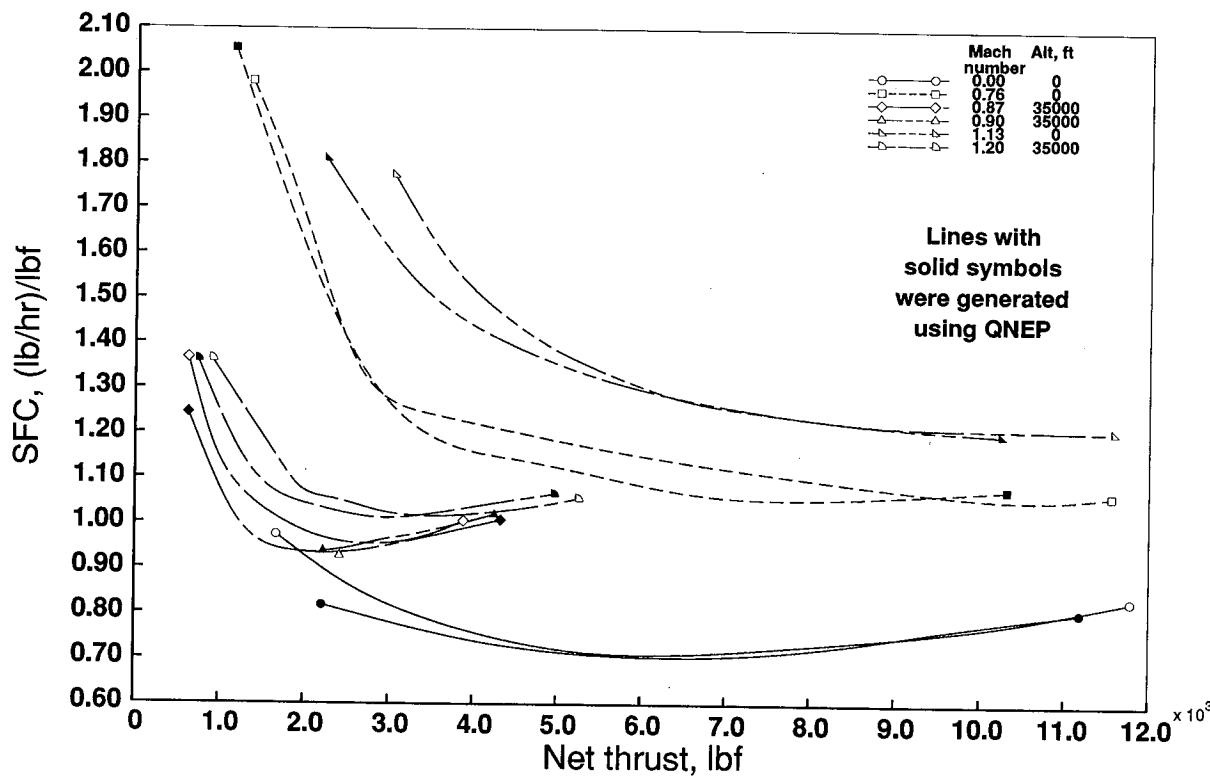


Figure 6. Accuracy of QNEP vs actual data for J79-GE-17 engine with afterburner off.

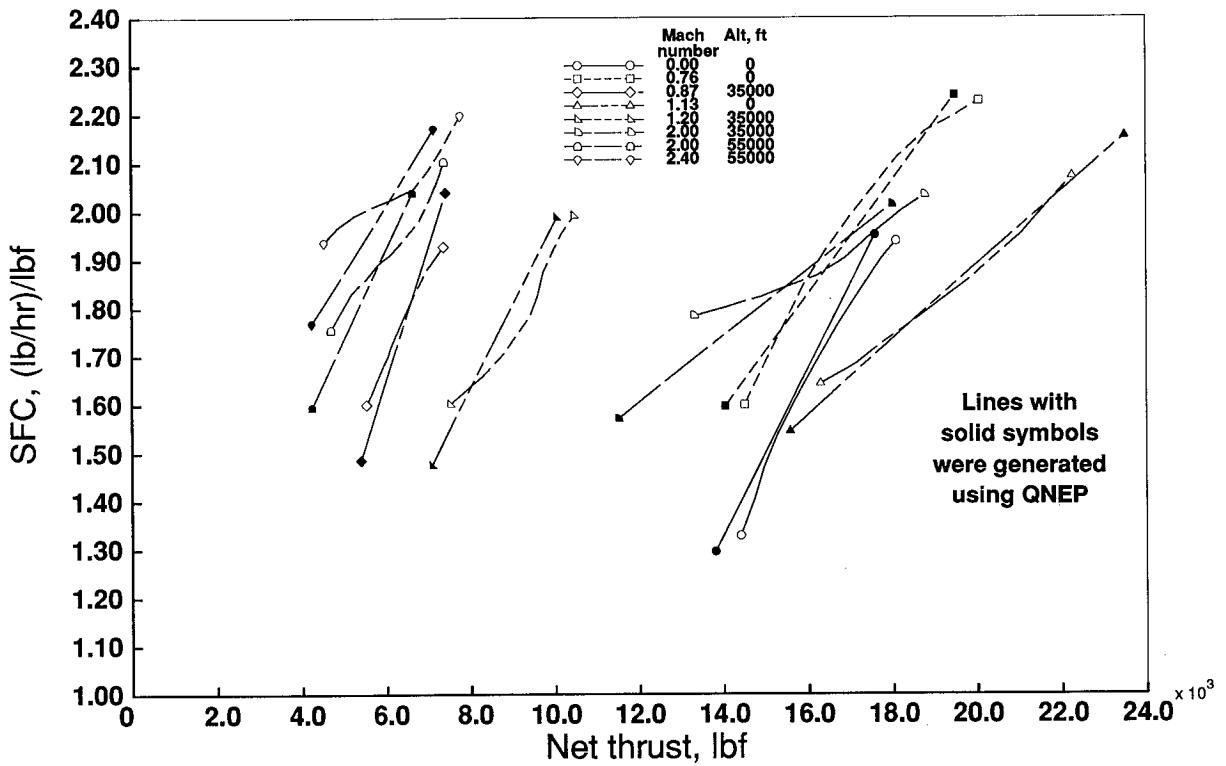


Figure 7. Accuracy of QNEP vs actual data for J79-GE-17 engine with afterburner on.

Fortran, allows the interactive generation of an input file, written in NAMELIST format, for use in QNEP. The user can specify their own configuration, select from a menu of existing configurations defined within QDATGEN, or modify a NAMELIST formatted configuration already available. Currently QDATGEN contains a data base of seven configurations, including two mixed-flow turbofan configurations, two unmixed-flow turbofan configurations, a dual-rotor turbojet, a single-shaft turbojet, and a ramjet. Detailed schematics of these configurations are provided in appendix B. Each configuration contains its own input data base, including table reference numbers, bleed and bypass ratios, pressure drops, and component design point parameters. The user can change any or all of these quantities for the selected configuration. For all configurations, there is a file that contains the default table data decks (see appendix B). This file must be available when QDATGEN is run. If the default table data decks are not wanted the user can (1) write their own data decks to the default file prior to running QDATGEN, (2) select another file or files to which the table data decks have been written, or (3) edit the resulting input file and add the table data decks

after running QDATGEN. If the default table data decks are not used, it may be necessary to modify more of the input data than would otherwise be necessary (i.e., *R*-value used to enter compressor tables, pressure ratio used to enter turbine tables, values of variable geometry parameters, table reference numbers, etc.). For example, if the default *R*-value for a particular default configuration is 2 (the *R*-value in the default compressor tables varies from 1 to 3) and the user selects a table wherein the *R*-value varies from 1 to 2, it may be necessary to reset the *R*-value to some other value between 1 and 2. If the user chooses to specify their own configuration, they are prompted for all input data required to fully describe the components in that configuration. The component codes used in QDATGEN are the same as those used in QNEP. Again, table data decks should be available on one or more files. QDATGEN output is a QNEP input file written in NAMELIST format to "TAPE5." Three sample cases are provided in appendix C. There are three options for creating the design point input data. The user can specify his own configuration and the design point data for that configuration, select from a menu of existing configurations defined within QDATGEN and make modifications

to the default design point data, or he can modify a NAMELIST formatted configuration already available. These options are described in the next three sections.

### User-Specified Configuration

The first NAMELIST input, the design point, is completely specified by the user. Before beginning, the user should have a schematic diagram of the configuration to be simulated with components and flow stations appropriately numbered. Any table data decks to be included should already be prepared. Once the user chooses to specify the engine, a brief description of the program, the component codes, and a list of possible table data decks is printed. Except where indicated within the program, all configuration and component data default to zero. As the configuration array is being entered, the data are checked for improper flow arrangements. After the configuration data have been entered, a check is made of the array for proper shaft connections and control data. Errors that are found can generally be corrected without restarting the program. Next the component details are entered, followed by the remaining NAMELIST variables and the table data decks. If all tables are in one file, the user is prompted for the file name and the data are read from that file and written to the input file following the design point NAMELIST input. If all tables are not on one file, the user is prompted for all possible tables in the selected configuration. The nondimensional referred flow schedule is a required table. If this is the only table or if the user chooses to add the tables after generating the input file, the answer to "Are all the table data decks in one file (Y/N)?" should be "Yes." Then the name of the file containing the flow schedule or the name of an empty file is entered. Appendix A contains a detailed description of all input and output variables. This option is illustrated by the first sample terminal session found in appendix C.

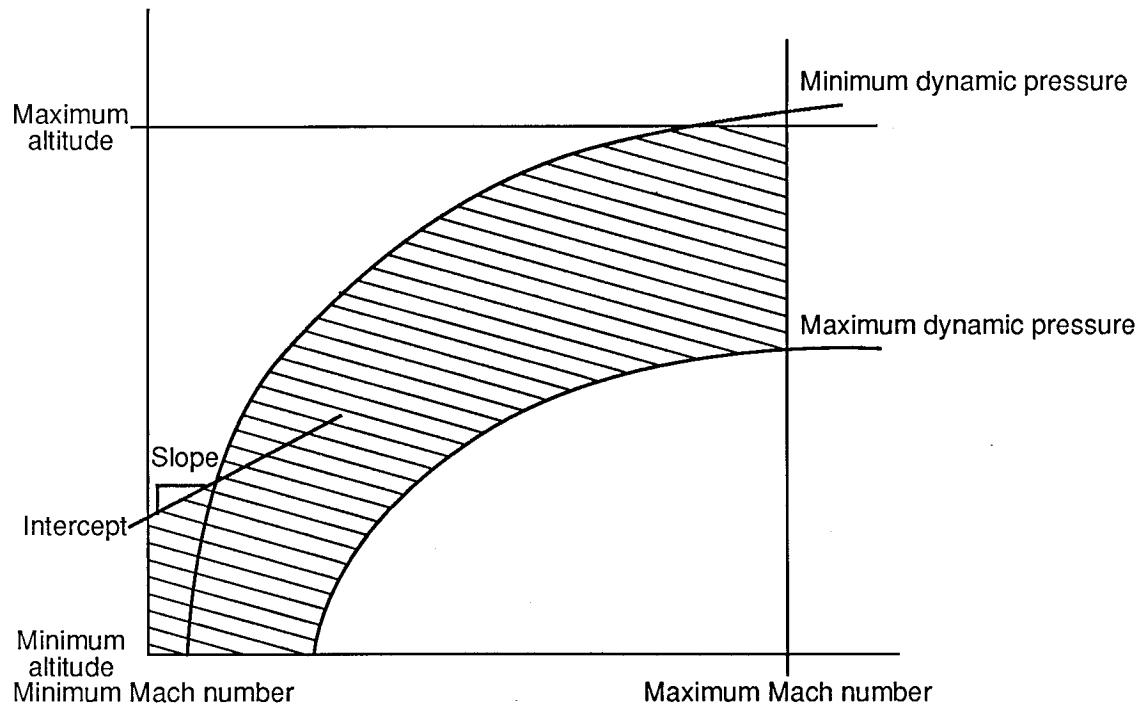
### Modifying an Existing NAMELIST Input

The option to modify an existing NAMELIST input allows the user to modify an existing file already in the proper NAMELIST format. The file must be available when QDATGEN is run, and although table data decks and other off-design point NAMELIST's may also be in the file, only the first NAMELIST, the design point, is accessed. The remaining data are not included in the resultant input file. In this case, only the component data can be changed; the configuration data are not changed. The component data, along with a brief description, are displayed in a tabular format for each component in the config-

uration. Changes are effected by entering the number of the data variable and the value. A carriage return with no data causes the next component to be displayed, and entering "15,15" causes the program to skip over the remaining components. After the changes have been made to the component data, the remaining NAMELIST input data (see appendix A) can be changed. Although the user is prompted to enter a number for each of these NAMELIST variables, a carriage return causes the value to default to the value in the original NAMELIST input. Table data decks are entered as in the previous case. Because the configuration data cannot be changed with this option, changes to control data are limited. In most cases, the required controls are not changed. If necessary, the configuration data may be changed by editing the resulting file. If other controls (controls that are not required, such as a design point control to fix the sea level static net thrust to some desired value) are needed they can be added from within QDATGEN by the user. This option is illustrated by the second sample terminal session found in appendix C.

### Modifying an Existing Configuration

The option to modify an existing configuration allows the user to modify one of the existing configurations in the data base. (See appendix B.) The data required to model these configurations and the coding necessary to change much of these data have been included in subroutines that are called from QDATGEN. For each component in the configuration, the user is given a list of selected input variables with a brief description and current value and is prompted for the letters corresponding to those variables requiring changes. The letters are entered without spaces, and the appropriate values are prompted for one by one. If no changes are desired for the component, a carriage return will cause the data for the next component to be listed. Once a letter is specified a value must be entered, since there is no default. Once all components in the configuration have been completed, the default table data deck reference numbers are listed and may be changed. These changes may be to another table reference number or to an actual value of the quantity described. In order to avoid overwhelming the user, some of the CDAT input array data for the default configurations are transparent to the user and cannot be changed from within QDATGEN. Hence, if the default tables are not used, it may be necessary to edit the resulting QNEP input file and change values such as reference areas or maximum referred flows associated with some of the tables. Each configuration



In generating a full set of data, all points in the shaded region that are multiples of the selected increments are included

Figure 8. Region of computation.

uses the same set of default tables that is read from file "DEFTAB," or the tables may be entered as in the previous two cases. Controls included in the data base are required for any off-design run. Additional controls can be added by the user. This option is illustrated by the third sample terminal session found in appendix C.

### Off-Design Point Input

After the first NAMELIST input, the remaining NAMELIST input is for off-design cases. First, the user is asked whether or not they want to generate a complete set of data. Each set requires two cases. The first case generates a NAMELIST input that initializes any variables that are common to the set. The second case actually generates many NAMELIST inputs, each consisting of a single Mach number and altitude combination and various throttle settings. The throttle settings are described by a starting turbine inlet temperature, the increment in throttle setting as defined by a change in temperature, and the number of throttle setting points up to a maximum of seven. Each of these quantities is fixed for all Mach number and altitude quantities in the set. The set can be defined by a minimum and max-

imum dynamic pressure in pounds per square foot a minimum and maximum altitude in feet, a minimum and maximum Mach number, and increments in altitude and Mach number. In order that points at low dynamic pressure can be included, a slope and an intercept for a line on a plot of altitude versus Mach number are also specified. Points below this line and within the range of Mach numbers and altitudes specified are included in the set. (See fig. 8.) A sample terminal session illustrating this option can be found in appendix C. As an alternative, the set can be defined as a constant-dynamic-pressure path or paths and a minimum and maximum Mach number. Here, the altitude is set to zero if, at the current Mach number, there is no positive altitude that will satisfy the selected constant dynamic pressure. If the user chooses not to generate a full set, any inputs can be changed as required except those quantities that are calculated during the design point phase, such as scale factors and flow areas. Changes to such quantities can be made by editing the resulting input file. If it is necessary to change the CDAT input for a particular component, the user is prompted for all quantities associated with the selected component. The program is structured such that each quantity defaults to the original value; thus a carriage return

is entered for all quantities except those requiring changes.

### Concluding Remarks

QNEP provides a reliable and accurate method of rapidly predicting the design point and off-design performance parameters for a variety of aircraft engines. It can be run on a computer having only 640 kilobytes of memory. The small memory requirements of QNEP should appeal to a wide range of users, including small companies or research organi-

zations and especially students. It has the potential to be linked directly to other computer programs (e.g., mission analyses, engine weights, engine costs, or noise calculations) that require propulsion performance data or aircraft engine thermodynamic cycle data.

NASA Langley Research Center  
Hampton, VA 23665-5225  
February 27, 1991

## Appendix A

### QNEP Users Guide

#### QNEP Description and Limitations

QNEP is a special version of NEPCOMP. In addition to the regular NEPCOMP options, the following new options are available:

1. Maximum referred flow at flow station number 2 must be specified as a function of  $\theta_{t,2}$  (and altitude). Referred flow is automatically reduced to this maximum limit by changing the burner outlet temperature. **The first table data deck must be the referred flow schedule.** (Note that the actual maximum referred flow is the table value multiplied by WMAX as defined below.) This may also be a function of a second parameter, altitude.
2. Dry duct pressure drops are automatically set as a function of the duct entrance corrected flow squared. This option may be defeated by resetting the duct inputs after the design point solution.
3. The first NAMELIST read must contain all the configuration and component data inputs necessary for the design point solution. The design point switch (IDESN) is automatically set by QNEP. The configuration inputs must not be changed after the design point is run. Other data may be changed through NAMELIST.
4. All controls except those necessary for the design point should be deactivated in the first NAMELIST input (the design point input). In the off-design point mode, controls applicable to the design point must be deactivated. The control set up for QNEP must be for fixed burner outlet temperature. All controls are activated by QNEP after the first NAMELIST input.
5. The second and subsequent NAMELIST reads are used to input off-design data. These reads are primarily used for changing altitude and Mach number. However, other inputs, except configuration inputs, may also be changed. Afterburners are activated by setting burner efficiencies greater than zero. Design point modes are run dry only. (All afterburner duct efficiencies are automatically set to zero.)
6. The capability of modeling vehicle forebody precompression by either a constant-angle wedge in the free stream or a constant shock wave angle has been added. (See CDAT(15,J) for the inlet.)

All input data, except case titles and table data decks, are input through NAMELIST format. Each group of cards begins with the NAMELIST identifier \$D, is followed by the NAMELIST inputs, and ends with the \$ delimiter. If a new title or tabular data are input, then it begins on the next card following the \$ delimiter. The input card after the last table data deck and before the next NAMELIST input must be blank. Figure A1 illustrates the basic input grouping and figure A2 illustrates the format of the tabular data.

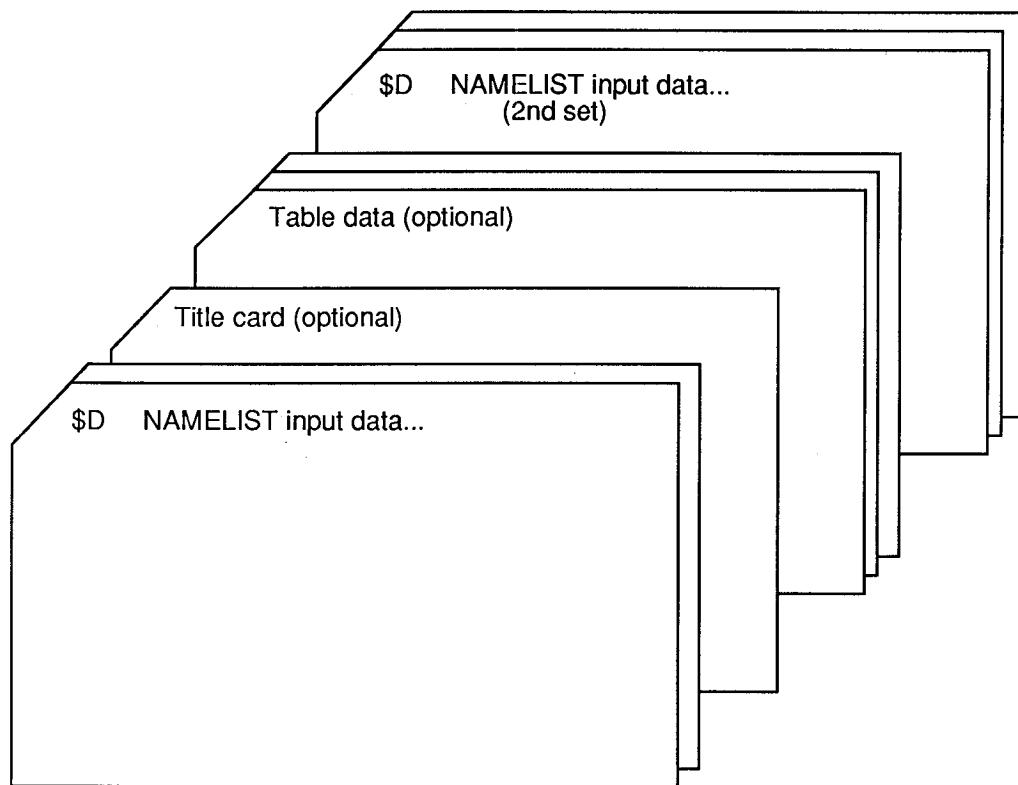


Figure A1. Input card data grouping.

123456789-123456789-123456789-123456789-123456789-123456789-123456789-123456789

NNNN Title for Table I

Z	NZ	Z1	Z2	Z3	...	ZNZ		
Y	NY	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Y	NY	Y8	Y9		...	YNY		
X	NX	X1	X2	X3	X4	X5	X6	X7
X	NX	X8	X9	...	XNX			
F	NF	F(1,1,1)	F(2,1,1)	F(3,1,1)	...			
F	NF	F(8,1,1)	F(9,1,1)	...	F(NX,1,1)			
F	NF	F(1,2,1)	...					
				.				
				.				
				.				
F	NF				...F(NX,NY,1)			
Y	NY	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Y	NY	Y8	Y9		...	YNY		
X	NX	X1	X2	X3	X4	X5	X6	X7
X	NX	X8	X9	...	XNX			
F	NF	F(1,1,2)	F(2,1,2)	F(3,1,2)	...			
F	NF	F(8,1,2)	F(9,1,2)	...				
F	NF	F(1,2,2)	...					
				.				
				.				
F	NF	F(8,NY,NZ)	...		F(NX,NY,NZ)			
EOT								

Where: NNNN is the table reference number  
Z, Y, X, and F are character strings of length four  
Zi, Yi, and Xi are numerical values  
F(i,j,k) is the numerical value function of Xi, Yj, and Zk  
NX, NY, NZ, and NF are the number of X, Y, Z, and F values

For F = function of Y and X only NZ=1 and Z1=0

For F = function of X only NZ=NY=1 and Z1=Y1=0

1st card FORMAT ( 1X,I4,7X,'TITLE' )

Data FORMAT ( A4.1X.T2.3X.7E10.n ) n is usually 3 to 4

Last card FORMAT ( 1X, 'EOT' )

**Figure A2.** Format for tabular data.

## Input Data

NCOMP	total number of simulation components ( <b>40 maximum</b> )
NOSTAT	total number of flow stations ( <b>44 maximum</b> )
IDESN	switch: <ul style="list-style-type: none"><li>0 indicates off-design mode</li><li>1 indicates design point mode calculation</li></ul>
IPRINT	switch: <ul style="list-style-type: none"><li>0 indicates regular solution printout</li><li>1 indicates extra print diagnostics</li><li>2 indicates full convergence history in addition to the regular solution printout</li></ul>
TITLE	switch: <ul style="list-style-type: none"><li>0 indicates no title</li><li>1 indicates that a title card will follow the card containing the \$ NAMELIST ending delimiter</li></ul>
TABLES	switch: <ul style="list-style-type: none"><li>0 indicates that no tables will be input</li><li>1 indicates that tables will follow the card containing the \$ NAMELIST ending delimiter (or title card if TITLE=1)</li><li>2 indicates that the input tabular data will also be printed</li></ul>
FIGSET	switch: <ul style="list-style-type: none"><li>0 indicates no change in the configuration data</li><li>1 indicates that the configuration data have been changed and will be reprocessed</li></ul>
WMAX	scalar multiplier on the table value of referred flow from the flow schedule
ALT	altitude, ft
NM	number of Mach numbers to be run at the current altitude ( <b>16 maximum</b> )
XMA	array of Mach numbers to be run at the current altitude ( <b>16 maximum</b> )
NP	number of throttle setting points to be run at the current Mach number and altitude ( <b>7 maximum</b> )
TDEL	array of burner outlet temperature (BOT) increments between throttle setting points ( <b>6 maximum</b> ) [ $BOT_{(I+1)} = BOT_{(I)} - TDEL_{(I)}$ ]
JCB	burner component number ( <b>must not be zero</b> )
JN1	core nozzle component number ( <b>must not be zero</b> )
JN2	fan nozzle component number (zero for no fan nozzle)
JCAB	array of afterburner component numbers ( <b>5 maximum</b> )
PUNCHO	switch: <ul style="list-style-type: none"><li>0 indicates no data on tape 9</li></ul>

1 indicates that Mach number, thrust, and fuel flow will be printed to tape 9 in a format compatible with other performance codes; the data and format written to tape 9 are given in figure A3

TIT turbine inlet temperature; default is the burner outlet temperature of the design point solution (entered as CDAT(4,JCB))

ENDRUN switch: 1 halts the computer run

The optimization variables NVOPT, NJOPT, TOLOPT, and IOPTP, available in NEPCOMP, are currently not used in QNEP. They are included here for completeness because they are declared in the program common block and NAMELIST statements.

NVOPT switch:

0 indicates optimization mode is not activated

1 to 9 indicates a performance property as the optimization dependent variable if NJOPT equals 0

1 to 9 indicates which output variable of component number NJOPT is the optimization dependent variable if NJOPT is not equal to 0 (if NVOPT is negative the dependent variable is maximized)

NJOPT switch:

0 indicates that the optimization independent variable is a performance property

>0 indicates the component number where the optimization dependent variable is located

TOLOPT optimization dependent variable tolerance (default=0.0002); TOLOPT should be set to the approximate noise level in the optimization objective; the user is cautioned against setting TOLOPT too low; the default value is correct for specific fuel consumption minimizations

IOPTP switch:

0 indicates that no optimization passes will be printed out, only the regular output

1 indicates that optimization passes will be output

### *JFIG(I,J)—Configuration Data Input*

The data in the JFIG array describe the basic configuration of the engine to be simulated. JFIG has the dimensions of 5 times the number of components (including controls) in the engine. The first element in the array can vary from 1 to 5 and the second varies from 1 to the total number of components in the configuration and in fact designates the component number. Thus, each component has five integer values associated with it. The first element always indicates what the component is, based on the codes identified in table A1. For flow-through components the second and third elements indicate flow station numbers where flow enters the component for primary and secondary flow, respectively. Similarly, the fourth and fifth elements indicate flow stations where flow leaves the component. Detailed definitions for these elements, for all component types, are given in tables A1 and A2. Where no definitions are given that element is either set to zero or left blank.

Example: JFIG(I,5)=4,5,0,6,20; I=1,5 indicates that component 5 is a compressor (code=4), that the primary flow stream enters at station 5 and leaves at station 6, and that bleed flow leaves the compressor at station 20. There is no secondary inlet flow allowed for compressor components (JFIG(3,5)=0).

123456789-123456789-123456789-123456789-123456789-...-1234567890					
MACH	NM	XMA(1)	XMA(2)	XMA(3)	... XMA(7)
		XMA(8)	XMA(8)	...	XMA(NM)
THR	NP	THR(1)	THR(2)	...	THR(NP)
WFD	NP	WFD(1)	WFD(2)	...	WFD(NP) Mach=XMA(1)
THR	NP	THR(1)	THR(2)	...	THR(NP)
WFD	NP	WFD(1)	WFD(2)	...	WFD(NP) Mach=XMA(2)
THR	NP	THR(1)	THR(2)	...	THR(NP)
WFD	NP	WFD(1)	WFD(2)	...	WFD(NP) Mach=XMA(3)
.					
THR	NP	THR(1)	THR(2)	...	THR(NP)
WFD	NP	WFD(1)	WFD(2)	...	WFD(NP) Mach=XMA(NP)
This pattern repeats for each NAMELIST input)					
Format on Mach number	( 'MACH', 4X, I2, 7(1X,F9.4) ) NM ≤ 7				
Format on Mach number	( 10X, 7(1X,F9 4) ) NM > 7				
Format on net thrust	( 'THR ', 4X, I2, 7(1X,F9 1) )				
Format on fuel flow	( 'WFD ', 4X, I2, 7(1X,F9 1) )				

Figure A3. Format of Mach number, thrust, and fuel flow (PUNCHO=1).

Table A1. JFIG Definition Codes

$$\left[ \begin{array}{l} \text{JFIG(I,J)=JFIG1,JFIG2,JFIG3,JFIG4,JFIG5; I=1,5;} \\ \text{J=COMPONENT NUMBER} \end{array} \right]$$

Code (JFIG1)	Component type	Definition number <sup>a</sup> for—			
		JFIG2	JFIG3	JFIG4	JFIG5
1	Inlet	1		2	
2	Duct, burner, or AB	1	3	2	4
3	Not used				
4	Compressor	1		2	4
5	Turbine	1	3	2	
6	Heat exchanger	1	5	9	6
7	Splitter	1		2	8
8	Mixer	1	7	8	
9	Nozzle	1		8	
10	Load				
11	Shaft	9	10	11	12
12	Control	13		14	
13	Optimization			15	
14	Limit			16	

<sup>a</sup>See table A2.

Table A2. JFIG Definitions

Component category	Number	Element	Definition
All flow-through components	1	JFIG2	Flow station number where the primary flow stream enters the component. In heat exchangers this is the stream receiving heat.
	2	JFIG4	Flow station number where the primary flow leaves the component. This flow station must not be a bleed flow station.
Ducts, turbines, and compressors	3	JFIG3	Flow station number where the bleed flow enters the component. Bleed flow may enter only ducts or turbines.
	4	JFIG5	Flow station number where the bleed flow leaves the component. Bleed flow may exit from ducts and compressors only.
Heat exchangers	5	JFIG3	Flow station number where the secondary or cross flow (flow that releases heat) enters the heat exchanger.
	6	JFIG5	Flow station number where the secondary or cross flow leaves the heat exchanger.
Splitters and mixers	7	JFIG3	Flow station number where the secondary flow stream enters the mixer.
	8	JFIG5	Flow station number where the bypass flow exits the splitter.  (These flow stations must not be bleed flow stations.)
Shafts	9	JFIG2	Component number of the first component connected to this shaft. This component number may indicate a compressor, turbine, load, or another shaft.
	10	JFIG3	Component number of the second connected component.
	11	JFIG4	Component number of the third connected component.
	12	JFIG5	Component number of the fourth connected component.

Table A2. Concluded

Component category	Number	Element	Definition
Controls	13	JFIG2	<p>Either a flow station number, a component number, or zero:</p> <p>Flow station number indicates the location of the control dependent variable and that it is a station property output.</p> <p>Component number indicates the location of the control dependent variable and that it is a DATOUT variable.</p> <p>Zero if the control dependent variable is a performance property.</p>
	14	JFIG4	<p>Component number where the independent variable is located. The control independent variable may only be one of the CDAT input variables.</p> <p>(Station property and performance property outputs are defined in section entitled "Component Code 12—Control." CDAT and DATOUT variables are different for each component and follow this table.)</p>
Optimization variable	15	JFIG4	Component number where one of the optimization independent variables is located. Independent variables may only be one of the CDAT input variables.
Limit variables	16	JFIG4	<p>Either a flow station number, a component number, or zero:</p> <p>Flow station number indicates the location of the limit variable and that it is a station property output.</p> <p>Component number indicates the location of the limit variable and that it is a DATOUT variable.</p> <p>Zero if the limit variable is a performance property.</p>

## *Component Code 1—Inlet*

### *Input data:*

CDAT(1,J)	inlet weight flow, lb/sec
CDAT(2,J)	if CDAT(9,J) = -1, then CDAT(2,J) equals free-stream static temperature in °R; otherwise CDAT(2,J) equals blank or zero
CDAT(3,J)	if CDAT(9,J) = -1, then CDAT(3,J) equals free-stream static pressure in psi; otherwise CDAT(3,J) equals blank or zero
CDAT(4,J)	inlet drag <b>or table</b> reference number; drag is input as $D/qA$ ; see CDAT(12,J) and CDAT(13,J)
CDAT(5,J)	inlet free-stream Mach number
CDAT(6,J)	inlet recovery <b>or table</b> reference number; if CDAT(6,J) equals blank or zero, then AIA recovery is implied
CDAT(7,J)	if CDAT(6,J) equals table reference number, then CDAT(7,J) equals maximum permitted referred flow used to enter recovery table; otherwise CDAT(7,J) equals blank or zero
CDAT(8,J)	if CDAT(6,J) is table reference number, then CDAT(8,J) equals scale factor on referred flow used to read recovery table; otherwise CDAT(8,J) equals blank or zero
CDAT(9,J)	altitude (see CDAT(11,J)); if CDAT(9,J) = -1, then CDAT(2,J) and CDAT(3,J) are used
CDAT(10,J)	free-stream fuel/air ratio—normally blank or zero
CDAT(11,J)	if CDAT(11,J) equals blank or zero, CDAT(9,J) is geometric altitude; otherwise CDAT(9,J) is geopotential altitude
CDAT(12,J)	if CDAT(4,J) is table reference number, then CDAT(12,J) = $A_{ref}$ ; if $A_{ref} < 0$ , then $A_{ref}$ is inlet area and drag is a function of $A_0/A_{ref}$ (mass-flow ratio) and Mach number; $A_0$ is free-stream tube area; if $A_{ref} > 0$ , drag is a function of referred flow ( $W\sqrt{\theta}/\delta$ )/ $A_{ref}$ (at inlet exit) and Mach number
CDAT(13,J)	if CDAT(4,J) is table reference number, then CDAT(13,J) equals scale factor SF multiplied by $D/qA$ to get drag
CDAT(14,J)	blank or zero
CDAT(15,J)	if less than zero, CDAT(15,J) is the precompression wedge angle, and if greater than zero, CDAT(15,J) is the precompression shock wave angle, both in degrees; for no precompression use CDAT(15,J) equals blank or zero

Example tables, where applicable, are shown in figure A4. The plots shown in this appendix are representative of the parameters presented and do not correspond to any real data or tables.

### *Output data:*

DATOUT(1,J)	inlet drag (ram plus spillage), lb
DATOUT(2,J)	free-stream velocity, ft/sec
DATOUT(3,J)	dynamic pressure, lb/ft <sup>2</sup>

DATOUT(4,J)	inlet temperature ratio ( $T_2/T_1$ )
DATOUT(5,J)	ram pressure ratio ( $P_2/P_1$ )
DATOUT(6,J)	inlet free-stream Mach number
DATOUT(7,J)	inlet recovery ( $P_{t,2}/P_{t,0}$ )
DATOUT(8,J)	referred total temperature at inlet exit, °R
DATOUT(9,J)	altitude as input, ft

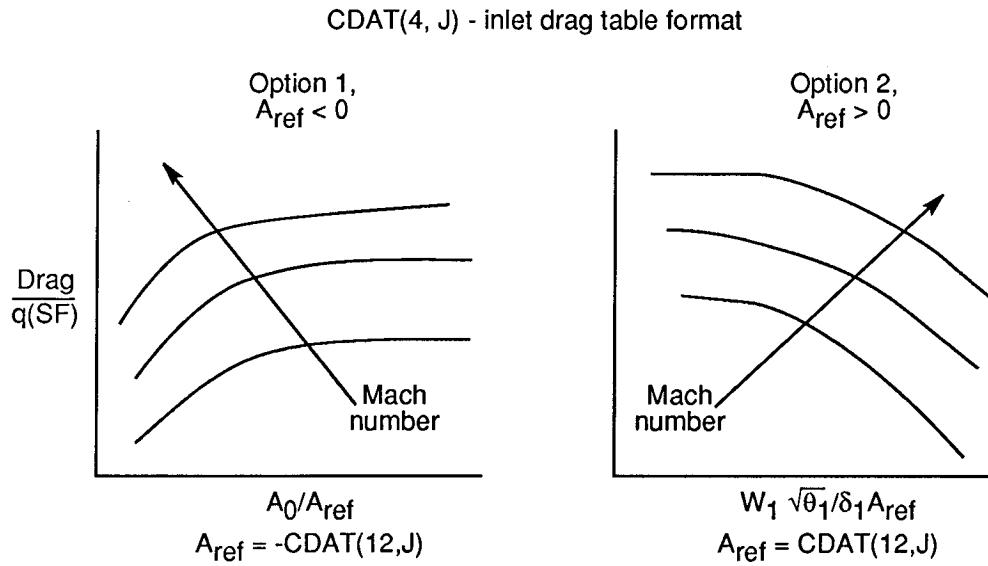
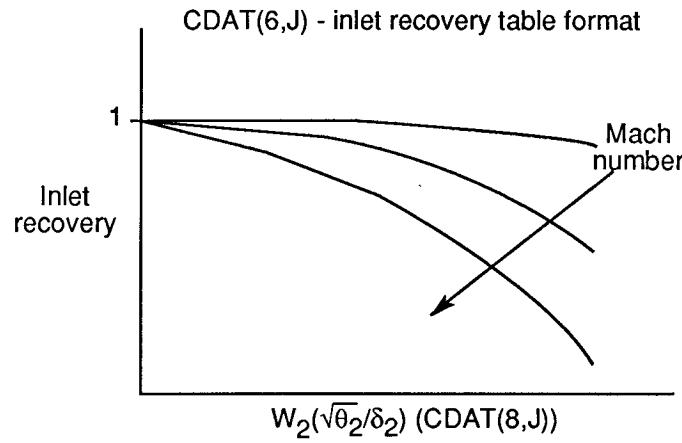


Figure A4. Inlet table data formats.

### Component Code 2—Duct, Burner, or Afterburner

*Input data:*

CDAT(1,J)       $\Delta P/P$  pressure drop or table reference number

CDAT(2,J)	if CDAT(5,J) equals blank or zero, CDAT(2,J) is not used; otherwise CDAT(2,J) equals design AB duct Mach number used to compute area for Rayleigh line momentum pressure drop; for no momentum pressure drop CDAT(2,J) equals blank or zero
CDAT(3,J)	if CDAT(1,J) is table reference number, CDAT(3,J) equals blank or zero; otherwise CDAT(3,J) is a coefficient on the corrected flow squared used as an adder to the CDAT(1,J) pressure drop
CDAT(4,J)	if CDAT(5,J) equals blank or zero, then CDAT(4,J) is ignored; otherwise CDAT(4,J) equals burner outlet temperature
CDAT(5,J)	if CDAT(5,J) equals blank or zero, the component is duct; otherwise CDAT(5,J) equals burner efficiency <b>or</b> table reference number
CDAT(6,J)	if CDAT(5,J) equals blank or zero, CDAT(6,J) is ignored; otherwise CDAT(6,J) equals fuel heating value <b>or</b> table reference number
CDAT(7,J)	if CDAT(5,J) equals blank or zero, CDAT(7,J) is ignored; otherwise CDAT(7,J) equals cross-sectional area ( $\text{in}^2$ ) used for momentum pressure drop calculation; if CDAT(2,J) is not zero and design point mode, CDAT(7,J) is computed
CDAT(8,J)	if CDAT(5,J) is not zero, CDAT(8,J) equals blank or zero; otherwise CDAT(8,J) equals fraction of total available bleed flow entering duct secondary inlet; if there is no bleed flow, CDAT(8,J) equals blank or zero
CDAT(9,J)	if CDAT(5,J) is not zero, then CDAT(9,J) equals blank or zero; otherwise CDAT(9,J) equals fraction of main exit flow directed to secondary bleed flow exit from duct
CDAT(10,J) to CDAT(15,J)	blank or zero

Example tables, where applicable, are shown in figure A5.

*Output data:*

DATOUT(1,J)	$\Delta P/P$ momentum pressure drop
DATOUT(2,J)	$\Delta P/P$ pressure drop obtained using CDAT(1,J) input
DATOUT(3,J)	design duct inlet Mach number used to compute area for momentum pressure drop calculations
DATOUT(4,J)	fuel flow to duct inlet flow ratio
DATOUT(5,J)	duct area (computed from design mode or input value) used to compute Mach number for momentum pressure drop
DATOUT(6,J)	fuel flow, lb/hr
DATOUT(7,J)	duct computed Mach number behind the fuel flame holders (behind dry drop, CDAT(1,J)) used in the momentum pressure drop calculation
DATOUT(8,J)	burner fuel heating value, Btu/lb
DATOUT(9,J)	burner efficiency

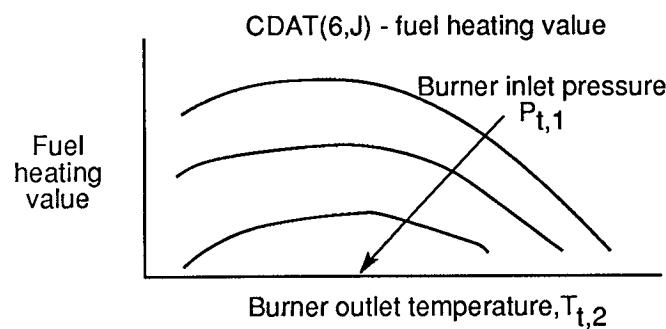
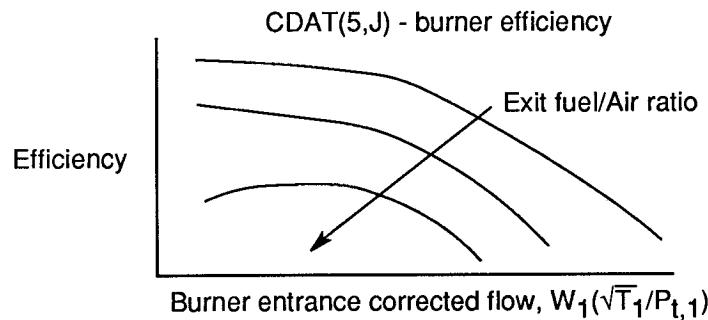
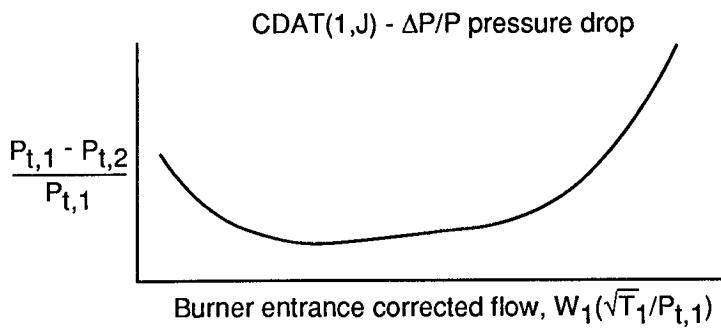


Figure A5. Duct and burner table data formats.

#### *Component Code 4—Compressor*

##### *Input data:*

CDAT(1,J)	<i>R</i> -value used to enter compressor tables; if there are no tables, CDAT(1,J) equals blank or zero
CDAT(2,J)	fraction of compressor inlet flow exiting compressor as bleed flow; if there is no bleed flow, CDAT(2,J) equals blank or zero
CDAT(3,J)	scalar multiplier on value of referred speed used to enter compressor tables; if design point mode, then CDAT(3,J) is computed; CDAT(3,J) is <i>never blank or zero</i>
CDAT(4,J)	referred flow at compressor inlet <b>or table reference number</b> ; CDAT(4,J) is <i>never blank or zero</i>

CDAT(5,J)	scalar multiplier of value of referred flow obtained from table or CDAT(4,J) directly; if design point mode, CDAT(5,J) is computed; CDAT(5,J) is <i>never blank or zero</i>
CDAT(6,J)	adiabatic efficiency <b>or table</b> reference number; CDAT(6,J) is <i>never blank or zero</i>
CDAT(7,J)	scalar multiplier of value of adiabatic efficiency obtained from table or CDAT(6,J) directly; if design point mode, CDAT(7,J) is computed; CDAT(7,J) is <i>never blank or zero</i>
CDAT(8,J)	compressor pressure ratio <b>or table</b> reference number; CDAT(8,J) is <i>never blank or zero</i>
CDAT(9,J)	scalar multiplier of pressure ratio obtained from table or directly from CDAT(8,J), defined as $(PR_{actual} - 1)/(PR_{table} - 1)$ ; if design point mode, CDAT(9,J) is computed; CDAT(9,J) is <i>never blank or zero</i>
CDAT(10,J)	value of third argument, such as stator angle, used to enter compressor tables when variable geometry characteristics are used; if there is no variable geometry, CDAT(10,J) equals blank or zero
CDAT(11,J)	fractional bleed horsepower loss due to inner stage bleeding; setting CDAT(11,J) equal to blank or zero indicates all of bleed flow has been taken off after full compression is achieved
CDAT(12,J)	if design point mode, CDAT(12,J) equals design adiabatic efficiency; otherwise CDAT(12,J) is ignored
CDAT(13,J)	if design point mode, CDAT(13,J) equals design pressure ratio; otherwise CDAT(13,J) is ignored
CDAT(14,J)	if design point mode, CDAT(14,J) equals value of referred speed used to enter tables at design point; otherwise CDAT(14,J) is ignored
CDAT(15,J)	blank or zero

Example tables, where applicable, are shown in figure A6.

#### *Output data:*

DATOUT(1,J)	compressor work, hp
DATOUT(2,J)	compressor physical shaft speed, rpm
DATOUT(3,J)	compressor variable geometry parameter
DATOUT(4,J)	<i>R</i> -value used to read compressor tables
DATOUT(5,J)	referred speed scale factor, CDAT(3,J) computed or otherwise input
DATOUT(6,J)	referred speed used to enter compressor tables
DATOUT(7,J)	referred flow scale factor, CDAT(5,J)
DATOUT(8,J)	compressor efficiency
DATOUT(9,J)	compressor pressure ratio

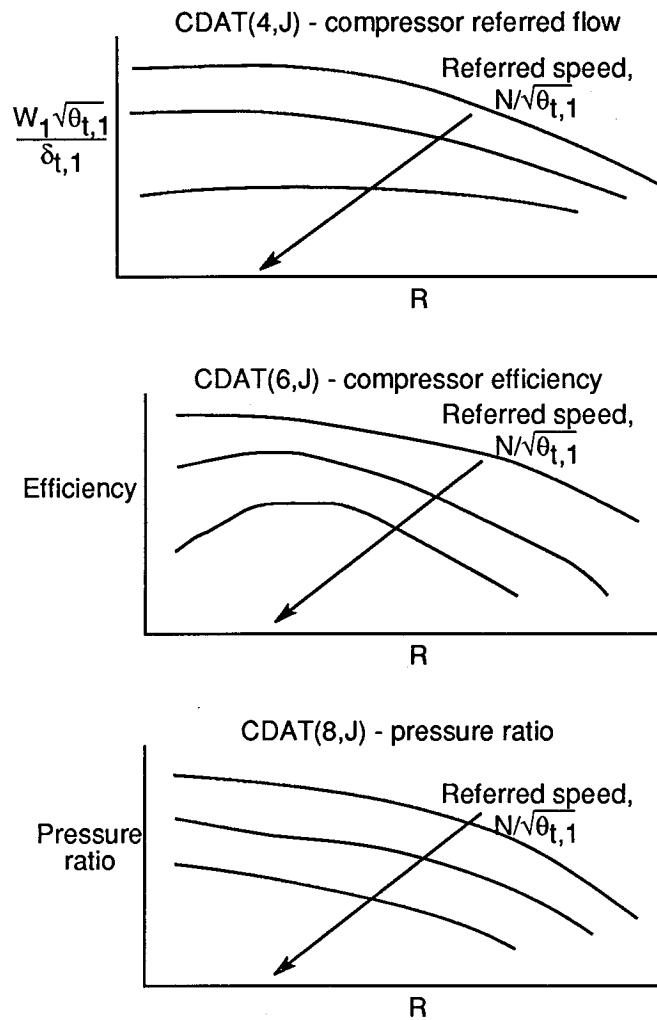


Figure A6. Compressor table data formats.

### Component Code 5—Turbine

#### *Input data:*

CDAT(1,J)	pressure ratio used to enter turbine tables; CDAT(1,J) must be greater than 1
CDAT(2,J)	fraction of the total available bleed flow that is entering the turbine; this fraction represents flow at both exit and entrance of turbine; if there is no bleed flow, then CDAT(2,J) equals blank or zero
CDAT(3,J)	scalar multiplier on value of referred speed used to enter turbine tables; if design point mode, CDAT(3,J) is computed; CDAT(3,J) is <i>never blank or zero</i>
CDAT(4,J)	referred flow at the turbine inlet <b>or table</b> reference number; CDAT(4,J) is <i>never blank or zero</i>
CDAT(5,J)	scalar multiplier on value of referred flow obtained from table or CDAT(4,J) directly; if design point mode, CDAT(5,J) is computed; CDAT(5,J) is <i>never blank or zero</i>
CDAT(6,J)	adiabatic efficiency <b>or table</b> reference number; CDAT(6,J) is <i>never blank or zero</i>

CDAT(7,J)	scalar multiplier of value of adiabatic efficiency obtained from table or CDAT(6,J) directly; if design point mode, CDAT(7,J) is computed; CDAT(7,J) is <i>never blank or zero</i>
CDAT(8,J)	scalar multiplier, defined as $(PR_{actual} - 1)/(PR_{table} - 1)$ , of value of turbine pressure rise ratio CDAT(1,J); if design point mode, then CDAT(8,J) is computed; CDAT(8,J) is <i>never blank or zero</i>
CDAT(9,J)	fraction of total turbine bleed flow entering the front of the turbine; this fraction will do work as it passes through turbine; the remaining part of the bleed flow entering the rear of the turbine does no work
CDAT(10,J)	value of third argument, such as stator angle, used to enter turbine tables when variable geometry characteristics are used; if there is no variable geometry, then CDAT(10,J) equals blank or zero
CDAT(11,J)	if design point mode, CDAT(11,J) equals design adiabatic efficiency; otherwise CDAT(11,J) is ignored
CDAT(12,J)	if design point mode, CDAT(12,J) equals value of referred speed used to enter tables at design point; otherwise CDAT(12,J) is ignored
CDAT(13,J)	if design point mode, CDAT(13,J) equals turbine horsepower split factor <sup>3</sup> ; CDAT(13,J) is <i>never blank or zero</i> (usually CDAT(13,J) = 1)
CDAT(14,J) to CDAT(15,J)	blank or zero

Example tables, where applicable, are shown in figure A7.

#### *Output data:*

DATOUT(1,J)	turbine work, hp
DATOUT(2,J)	turbine physical shaft speed, rpm
DATOUT(3,J)	turbine variable geometry parameter
DATOUT(4,J)	pressure ratio value used to read turbine tables
DATOUT(5,J)	turbine inlet rotor temperature computed from the flow weighted enthalpy of the main and bleed flows
DATOUT(6,J)	referred speed used to enter turbine tables
DATOUT(7,J)	referred flow scale factor, CDAT(5,J)
DATOUT(8,J)	turbine efficiency
DATOUT(9,J)	turbine overall pressure ratio

---

<sup>3</sup> The turbine horsepower split factor is used when more than one turbine drives a single shaft. The split factor is the ratio of the horsepower supplied by the turbine in question to the total horsepower required to balance the shaft. The sum of the split factors for all turbines driving the shaft must equal 1.

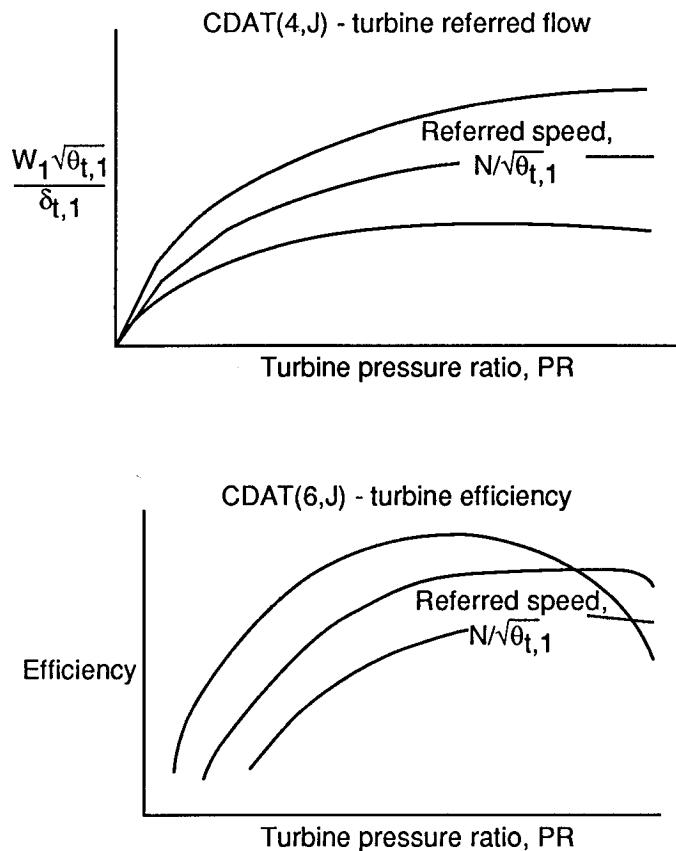


Figure A7. Turbine table data formats.

#### *Component Code 6—Heat Exchanger*

*Input data:*

CDAT(1,J)	$\Delta P/P$ pressure drop <b>or table</b> reference number for main flow stream (the main flow stream is the flow stream receiving heat)
CDAT(2,J)	$\Delta P/P$ pressure drop <b>or table</b> reference number for secondary flow stream (the secondary flow stream is the flow stream releasing heat)
CDAT(3,J)	temperature rise ratio guess value (main exit flow stream/main flow entrance); CDAT(3,J) is <i>never blank or zero</i>
CDAT(4,J)	heat exchanger effectiveness <b>or table</b> reference number; CDAT(4,J) is <i>never blank or zero</i>
CDAT(5,J)	scalar multiplier on value of heat exchanger effectiveness obtained from table or CDAT(4,J) directly; CDAT(5,J) is <i>never blank or zero</i>
CDAT(6,J) to CDAT(15,J)	blank or zero

Example tables, where applicable, are shown in figure A8.

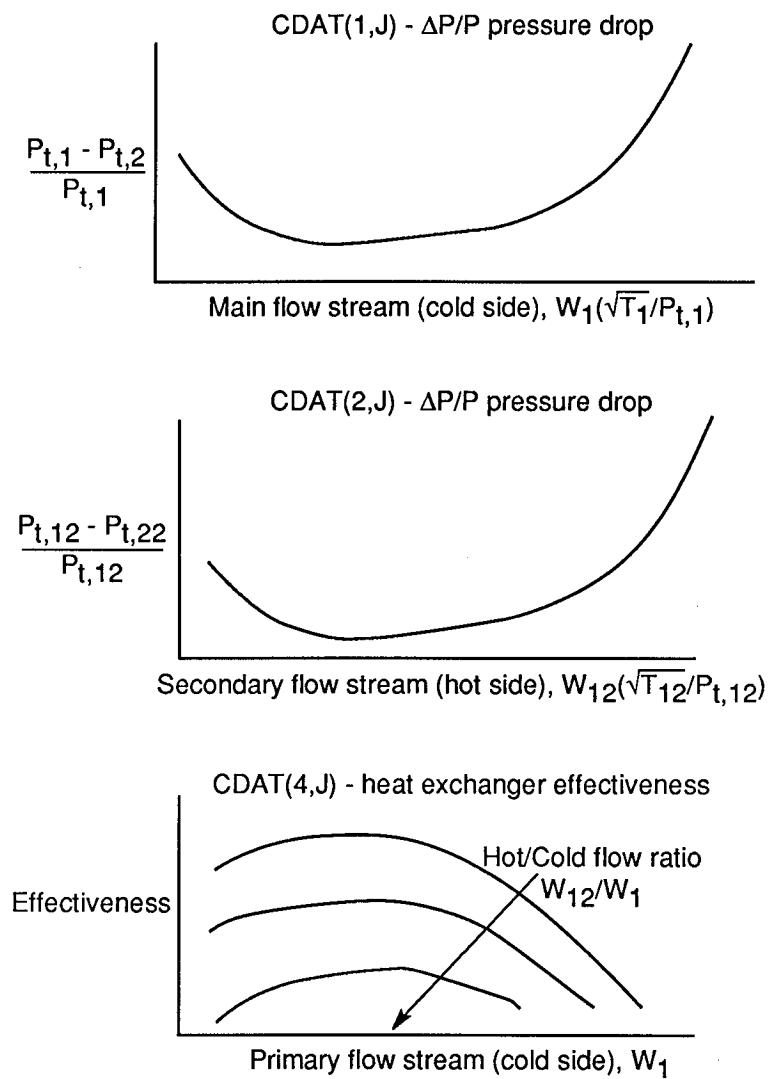


Figure A8. Heat exchanger table data formats.

*Output data:*

- |              |  |
|--------------|--|
| DATAOUT(1,J) | $\Delta P/P$ total pressure drop, main flow stream                                       |
| DATAOUT(2,J) | $\Delta P/P$ total pressure drop, secondary flow stream                                  |
| DATAOUT(3,J) | not applicable   |
| DATAOUT(4,J) | heat exchanger effectiveness   |
| DATAOUT(5,J) | scale factor on heat exchanger effectiveness   |
| DATAOUT(6,J) | temperature rise across the main flow stream, $^{\circ}\text{R}$                         |
| DATAOUT(7,J) | temperature rise ratio, $(T_{t,2} - T_{t,1})/(T_{t,12} - T_{t,1})$                       |
| DATAOUT(8,J) | temperature rise ratio error, $(T_{\text{guess}} - T_{\text{actual}})/T_{\text{actual}}$ |

### *Component Code 7—Splitter*

*Input data:*

CDAT(1,J)	bypass ratio, defined as ratio of weight flows leaving splitter, $W_{\text{bypass exit}}/W_{\text{main exit}}$
CDAT(2,J)	$\Delta P/P$ pressure drop <b>or table</b> reference number of the pressure drop across the main flow stream exit
CDAT(3,J)	$\Delta P/P$ pressure drop <b>or table</b> reference number of the pressure drop across the secondary flow stream exit
CDAT(4,J) to CDAT(15,J)	blank or zero

Example tables, where applicable, are shown in figure A9.

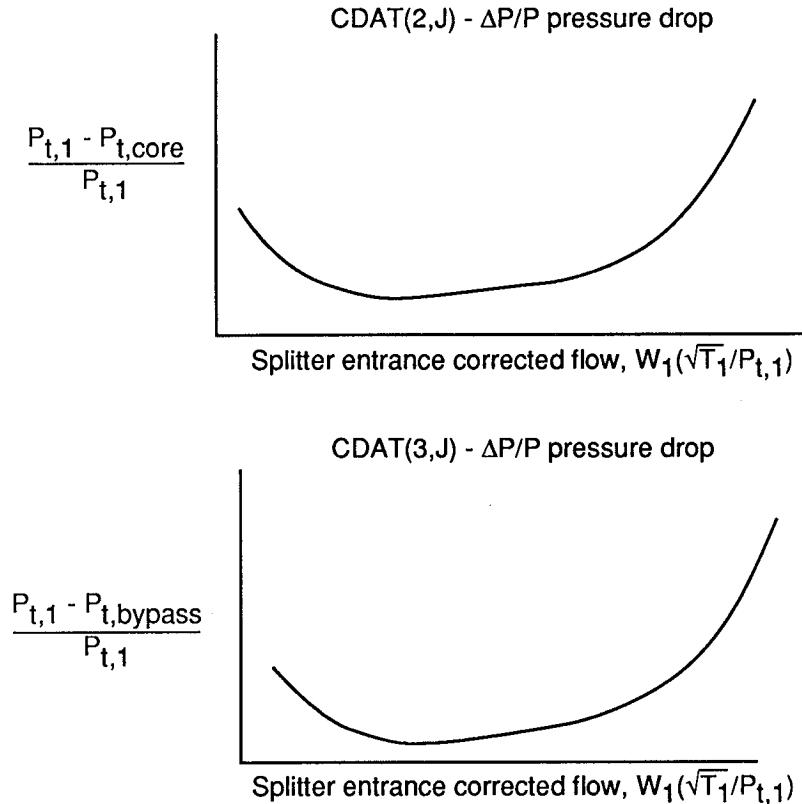


Figure A9. Splitter table data formats.

*Output data:*

DATOUT(1,J)	bypass ratio, $W_{\text{bypass exit}}/W_{\text{main exit}}$
DATOUT(2,J)	$\Delta P/P$ pressure drop, main flow
DATOUT(3,J)	$\Delta P/P$ pressure drop, secondary flow
DATOUT(4,J) to DATOUT(9,J)	not applicable

## *Component Code 8—Mixer*

### *Input data:*

CDAT(1,J)	area, in <sup>2</sup> , of main stream flow entrance; if design point mode, CDAT(1,J) is computed
CDAT(2,J)	area, in <sup>2</sup> , of secondary stream flow entrance; if design point mode, CDAT(2,J) is computed
CDAT(3,J)	if design point mode and CDAT(3,J) is less than 1, then CDAT(3,J) equals design Mach number of entering main flow stream; if design point mode and CDAT(3,J) is greater than 1, then CDAT(3,J) equals design pressure ratio of entering main flow stream; otherwise CDAT(3,J) is ignored
CDAT(4,J)	velocity ratio, actual/ideal, of mixed flow stream exiting mixer (usually CDAT(4,J) not blank or zero)
CDAT(5,J) to CDAT(15,J)	blank or zero

### *Output data:*

DATOUT(1,J)	main flow stream cross section area, in <sup>2</sup>
DATOUT(2,J)	secondary flow stream cross section area, in <sup>2</sup>
DATOUT(3,J)	total-to-static-pressure ratio across mixer main flow entrance
DATOUT(4,J)	total-to-static-pressure ratio across mixer secondary flow entrance
DATOUT(5,J)	main flow stream entrance velocity, ft/sec
DATOUT(6,J)	secondary flow stream entrance velocity, ft/sec
DATOUT(7,J)	velocity of the mixed flow stream exiting the mixer, ft/sec
DATOUT(8,J)	mixer static-pressure balance relative error, $\frac{2(P_{s,1} - P_{s,12})}{P_{s,1} - P_{s,12}}$
DATOUT(9,J)	mixer flow total-to-static-pressure ratio across the mixer flow exit

## *Component Code 9—Nozzle*

### *Input data:*

CDAT(1,J)	nozzle throat flow area, in <sup>2</sup> ; if design point mode, CDAT(1,J) is computed; CDAT(1,J) is <i>never blank or zero</i>
CDAT(2,J)	nozzle flow coefficient, defined as nozzle flow ratio $W_{\text{actual}}/W_{\text{ideal}}$ , <b>or table</b> reference number; if CDAT(2,J) equals blank or zero, then CDAT(2,J) is set equal to 1
CDAT(3,J)	aft end drag $D/qA$ <b>or table</b> reference number with $D/qA$ as a function of nozzle OPR and Mach number
CDAT(4,J)	if CDAT(9,J) equals blank or zero, then CDAT(4,J) equals nozzle ambient exit static pressure, lb/in <sup>2</sup> ; otherwise CDAT(4,J) equals blank or zero

CDAT(5,J)	nozzle velocity (or thrust coefficient) <b>or table</b> reference number of such; CDAT(5,J) is <i>never blank or zero</i>
CDAT(6,J)	switch: CDAT(6,J) equals blank or zero indicates nozzle type is convergent; otherwise nozzle type is convergent-divergent with full expansion to ambient
CDAT(7,J)	switch: if CDAT(7,J) is not blank or zero, then nozzle area is computed to match flow conditions; note CDAT(1,J) is not changed in this calculation; this switch is used for AB modes of operation
CDAT(8,J)	nozzle exit/throat area ratio <b>or table</b> reference number used to enter table at CDAT(5,J); if CDAT(5,J) is invariant with area ratio, then CDAT(8,J) equals blank or zero
CDAT(9,J)	if CDAT(4,J) equals blank or zero, then CDAT(9,J) equals component reference number of inlet component; CDAT(9,J) is used to automatically set nozzle exit pressure to inlet ambient pressure
CDAT(10,J)	if CDAT(3,J) is table reference number, then CDAT(10,J) is the scale factor multiplied on $D/qA$ to get drag
CDAT(11,J) to CDAT(15,J)	blank or zero

Example tables, where applicable, are shown in figure A10.

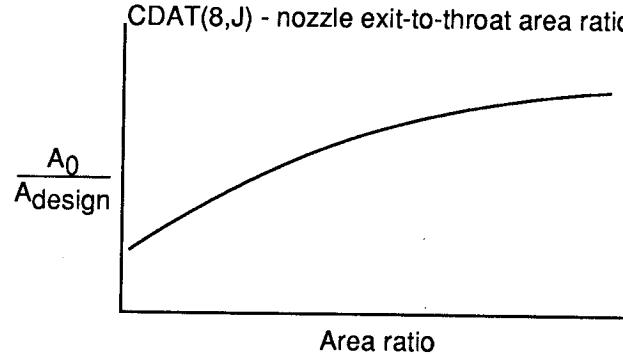
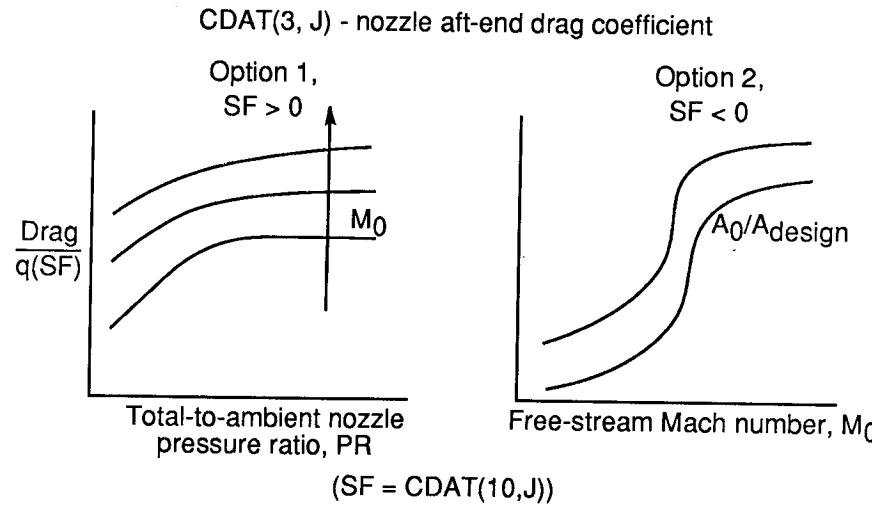
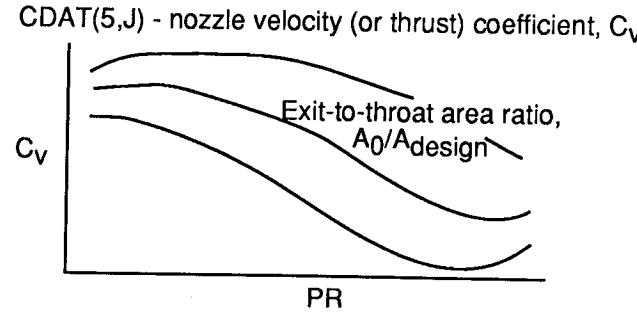
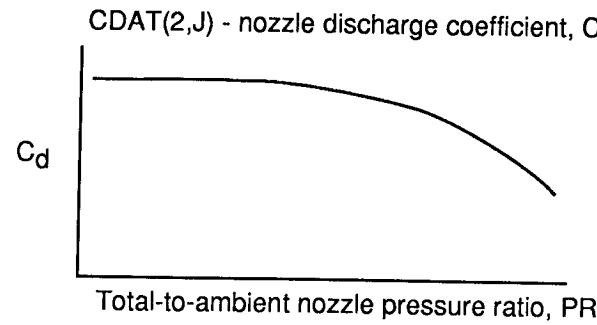
*Output data:*

DATOUT(1,J)	nozzle gross thrust, lbf
DATOUT(2,J)	actual nozzle velocity, ft/sec
DATOUT(3,J)	nozzle exit area computed from CDAT(8,J) and throat, in <sup>2</sup>
DATOUT(4,J)	ideal nozzle velocity, ft/sec
DATOUT(5,J)	nozzle throat area, in <sup>2</sup>
DATOUT(6,J)	nozzle discharge coefficient
DATOUT(7,J)	nozzle thrust coefficient
DATOUT(8,J)	nozzle drag, lbf
DATOUT(9,J)	nozzle total-to-ambient pressure ratio

*Component Code 10—Load*

*Input data:*

CDAT(1,J)	load horsepower <b>or table</b> reference number (positive horsepower is work added to system)
CDAT(2,J)	switch: CDAT(2,J) = 1 indicates this load absolute horsepower will be summed in the overall performance summary
CDAT(3,J) to CDAT(15,J)	blank or zero



Note: CDAT(1,J) is the design area;  
the area ratio is computed when CDAT(7,J) is not zero

Figure A10. Nozzle table data formats.

Example tables, where applicable, are shown in figure A11.

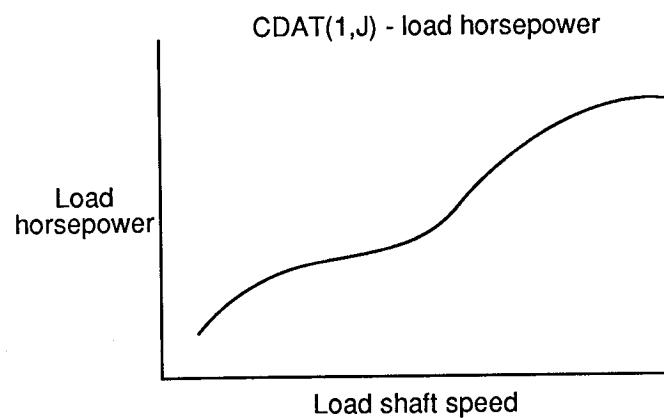


Figure A11. Load table data formats.

*Output data:*

DATOUT(1,J)	load horsepower, hp
DATOUT(2,J)	load shaft speed, rpm
DATOUT(3,J) to DATOUT(9,J)	not applicable

*Component Code 11—Shaft*

*Input data:*

CDAT(1,J)	shaft rpm, actual
CDAT(2,J)	gear ratio, rpm of first connected component/Actual shaft rpm
CDAT(3,J)	mechanical efficiency of first connected component (Output horsepower/Input horsepower)
CDAT(4,J)	gear ratio, rpm of second connected component/Actual shaft rpm
CDAT(5,J)	mechanical efficiency of second connected component (Output horsepower/Input horsepower)
CDAT(6,J)	gear ratio, rpm of third connected component/Actual shaft rpm
CDAT(7,J)	mechanical efficiency of third connected component (Output horsepower/Input horsepower)
CDAT(8,J)	gear ratio, rpm of fourth connected component/Actual shaft rpm
CDAT(9,J)	mechanical efficiency of fourth connected component (Output horsepower/Input horsepower)
CDAT(10,J) to CDAT(15,J)	blank or zero

*Output data:*

DATOUT(1,J)	net shaft horsepower, hp
-------------	--------------------------

DATOUT(2,J)	actual shaft speed, rpm
DATOUT(3,J)	actual shaft speed of first connected component, rpm
DATOUT(4,J)	actual shaft speed of second connected component, rpm
DATOUT(5,J)	actual shaft speed of third connected component, rpm
DATOUT(6,J)	actual shaft speed of fourth connected component, rpm
DATOUT(7,J)	not applicable
DATOUT(8,J)	net shaft power divided by the average shaft power
DATOUT(9,J)	not applicable

*Component Code 12—Control*

*Input data:*

CDAT(1,J)	if CDAT(1,J) equals blank or zero, then this control is inactive; if CDAT(1,J) = 1, this control is active and will converge the dependent variable to the desired value plus or minus the standard system tolerance (0.001); otherwise the value of CDAT(1,J) will be used as the tolerance during convergence to the desired value
CDAT(2,J)	CDAT(2,J) is equal to the minimum value of the independent variable for this control; this limit is active only in the optimization mode of NEP II; if optimization is not activated, then CDAT(2,J) is ignored; if no limit is required during optimization, CDAT(2,J) is set to zero (requires optimization mode)
CDAT(3,J)	CDAT(3,J) is exactly analogous to CDAT(2,J) except it applies to the maximum value; all definitions apply (requires optimization mode)
CDAT(4,J)	a value from 1 to 13 indicating which CDAT is the independent variable; the component number of this CDAT is indicated by the value of JFIG(4,J) for this control
CDAT(5,J)	desired value of the control dependent variable
CDAT(6,J)	a two-digit number used to indicate the dependent variable of the control; the value of JFIG2 for this control indicates either the component number or the flow station number where the dependent variable is located; the definitions are summarized in table A3
CDAT(7,J) to CDAT(15,J)	blank or zero

There is no output for control components.

Table A3. CDAT(6,J) Definition Summary

Digit 1	Digit 2	JFIG2
0	1 to 8—station property	Flow station no.
1	1 to 9—component output data	Component no.
2	1 to 9—performance property	Ignored

The station properties and performance properties are listed in tables A4 and A5.

Table A4. Station Property Code Definitions

Code number	Definition
1	Weight flow, lb/sec
2	Total pressure, lb/in <sup>2</sup>
3	Total temperature, °R
4	Fuel-to-air ratio
5	Referred flow, $W \sqrt{\theta_{t,2}} / \delta_{t,2}$ , lb/sec
6	Mach number
7	Static pressure, lb/in <sup>2</sup>
8	Interface relative flow error

Table A5. Performance Property Code Definitions

Code number	Definition
1	Net thrust, lbf
2	Brake shaft horsepower (BSHP), hp
3	Airflow, lb/sec
4	Thrust SFC, (lb/hr)/lbf
5	Brake SFC, (lb/hr)/hp
6	Fuel flow, lb/hr
7	Thrust-to-airflow ratio, lbf-sec/lb
8	Net BSHP-to-airflow ratio, hp-sec/lb
9	Inlet drag, lbf

### *Component Code 13—Optimization*

Included for completeness, optimization is not currently available in QNEP.

#### *Input data:*

- CDAT(1,J) if CDAT(1,J) equals blank or zero, then this optimization variable is inactive; if CDAT(1,J) = 1, then this optimization variable is active
- CDAT(2,J) CDAT(2,J) is the minimum value of the optimization variable; if no minimum constraint is desired, CDAT(2,J) equals blank or zero
- CDAT(3,J) CDAT(3,J) is the maximum value of the optimization variable; if no maximum constraint is desired, CDAT(3,J) equals blank or zero
- CDAT(4,J) a value from 1 to 15 indicating which CDAT is the optimization independent variable; the component number of this CDAT is indicated by the value of JFIG(4,J) for this optimization variable
- CDAT(5,J) to CDAT(15,J) blank or zero

## *Component Code 14—Limit*

*Input data:*

CDAT(1,J)	if CDAT(1,J) equals blank or zero, then this limit variable is inactive; if CDAT(1,J) = 1, then this limit variable is active
CDAT(2,J)	CDAT(2,J) is the minimum value of the limit variable; if no minimum constraint is desired, CDAT(2,J) equals blank or zero
CDAT(3,J)	CDAT(3,J) is the maximum value of the limit variable; if no maximum constraint is desired, CDAT(3,J) equals blank or zero
CDAT(4,J)	a two digit indicator:  if the first digit equals 0, then the second digit is a value from 1 to 8 indicating a station property as the limit variable; the station number of this property is indicated by the value of JFIG(4,J) for this limit variable  if the first digit equals 1, then the second digit is a value from 1 to 9 indicating a DATOUT as the limit variable; the component number of this DATOUT is indicated by the value of JFIG(4,J) for this limit variable  if the first digit equals 2, then the second digit is a value from 1 to 8 indicating one of the overall performance properties as the limit variable
CDAT(5,J) to CDAT(15,J)	blank or zero

## **QNEP Output**

In addition to the DATOUT variables described with the component input data the following data are given in the regular solution printout:

ALTITUDE	geometric (CDAT(11,J) for the inlet is zero) or geopotential altitude, ft
MACH	free-stream Mach number
FN	net thrust, lbf
BSHP	brake shaft horsepower, hp
WF	fuel flow, lb/hr
TSFC	thrust specific fuel consumption, (lb/hr)/lbf
REF FLOW	inlet referred flow, $W \sqrt{\theta_{t,2}/\delta_{t,2}}$ , lb/sec
BPR	bypass ratio, Bypass airflow/Core airflow
BOT	burner outlet temperature, °R
T19	secondary nozzle total temperature, °R
PR19	secondary nozzle pressure ratio

A19	secondary nozzle area, in <sup>2</sup>
T9	primary nozzle total temperature, °R
PR9	primary nozzle pressure ratio
A9	primary nozzle area, in <sup>2</sup>
RR	inlet ram recovery
NIT	number of iterations
V9	primary nozzle jet velocity, ft/sec

## Appendix B

### Existing Configurations in Engine Data Base

QDATGEN contains a data base of seven engine configurations, including two unducted turbofans, two ducted turbofans, two turbojets, and a ramjet. None of these configurations have been optimized for any particular application and all use the default tables located on file "DEFTAB." The default compressor (and fan) maps, shown in figures 1 and 2, are scaled based on the desired design point operating conditions. The remainder of appendix B contains a brief description along with a detailed schematic showing the layout and control characteristics for each of these configurations. Modifications to the design point data defined in the default configurations are accomplished interactively by running QDATGEN.

#### Dual-Rotor Turbofan—Default Configuration 1

This configuration (fig. B1) contains 28 components, including 8 controls. The low-pressure rotor drives a fan and the high-pressure rotor drives a compressor. As with the fan and compressor the turbine tables are the same for both the high- and low-pressure rotors. The bypass and core flows are mixed before entering a common afterburner and nozzle. (Note that the afterburner can be effectively eliminated by setting the pressure drop to zero in component number 14.) The default tables are on "DEFTAB," and the default table reference numbers are as follows:

- 11        inlet pressure recovery (MIL-E-5007D)
- 701      referred flow (fan)
- 702      adiabatic efficiency (fan)
- 703      pressure ratio (fan)
- 701      referred flow (high-pressure compressor)
- 702      adiabatic efficiency (high-pressure compressor)
- 703      pressure ratio (high-pressure compressor)
- 121      referred flow (high-pressure turbine)
- 122      adiabatic efficiency (high-pressure turbine)
- 121      referred flow (low-pressure turbine)
- 122      adiabatic efficiency (low-pressure turbine)
- 111      referred flow schedule

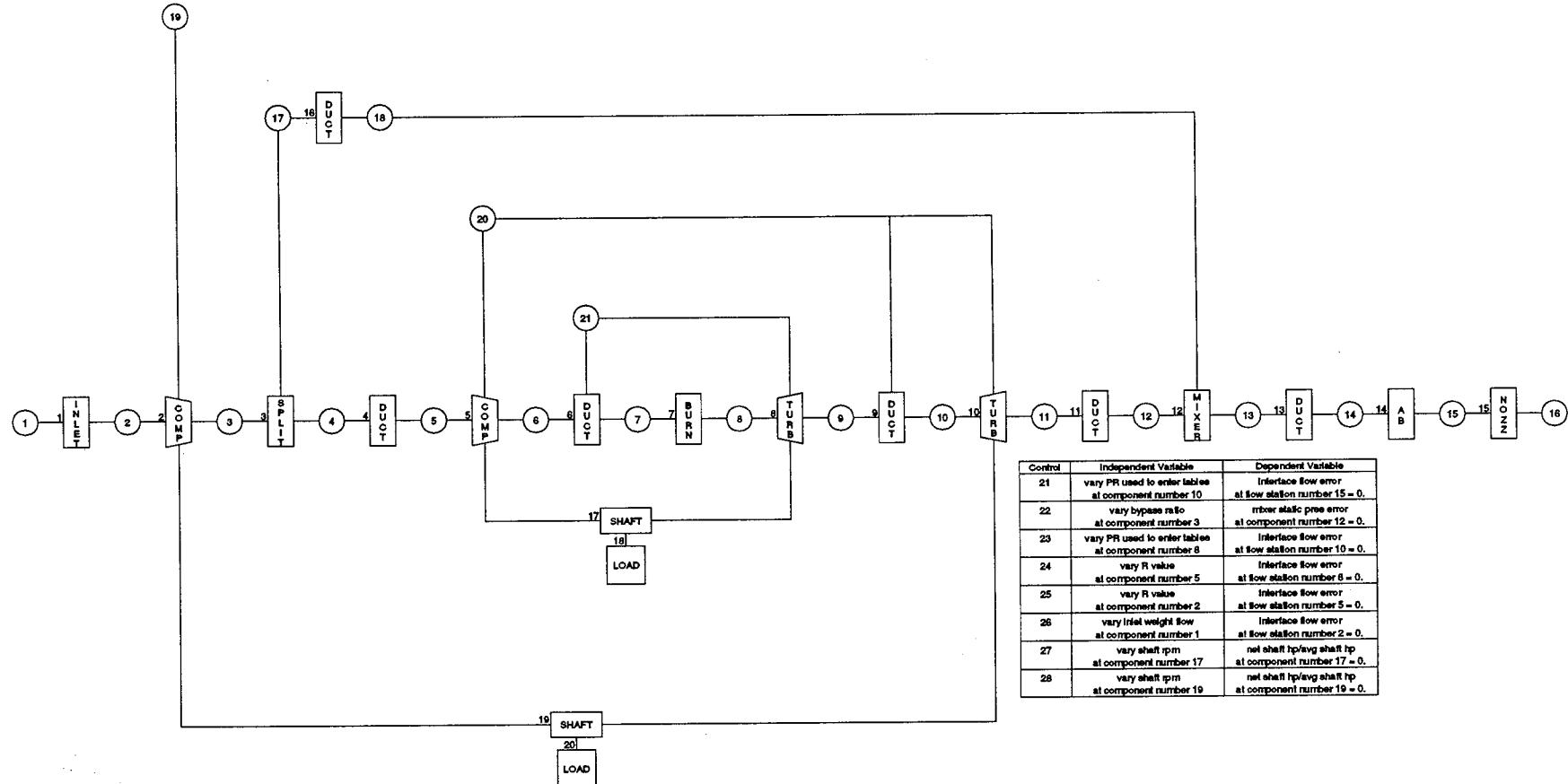


Figure B1. Default configuration 1.

## **Dual-Rotor Turbofan—Default Configuration 2**

This configuration (fig. B2) contains 31 components, including 9 controls. The low-pressure rotor drives a fan and a compressor and the high-pressure rotor drives a compressor. All bypass airflow passes through the low-pressure fan only and all the core flow passes through the fan and both compressors. The bypass and core flows are mixed before entering a common afterburner and nozzle. The default tables are on “DEFTAB,” and the default table reference numbers are as follows:

- 11      inlet pressure recovery (MIL-E-5007D)
- 701     referred flow (fan)
- 702     adiabatic efficiency (fan)
- 703     pressure ratio (fan)
- 701     referred flow (low-pressure compressor)
- 702     adiabatic efficiency (low-pressure compressor)
- 703     pressure ratio (low-pressure compressor)
- 701     referred flow (high-pressure compressor)
- 702     adiabatic efficiency (high-pressure compressor)
- 703     pressure ratio (high-pressure compressor)
- 121     referred flow (high-pressure turbine)
- 122     adiabatic efficiency (high-pressure turbine)
- 121     referred flow (low-pressure turbine)
- 112     adiabatic efficiency (low-pressure turbine)
- 111     referred flow schedule

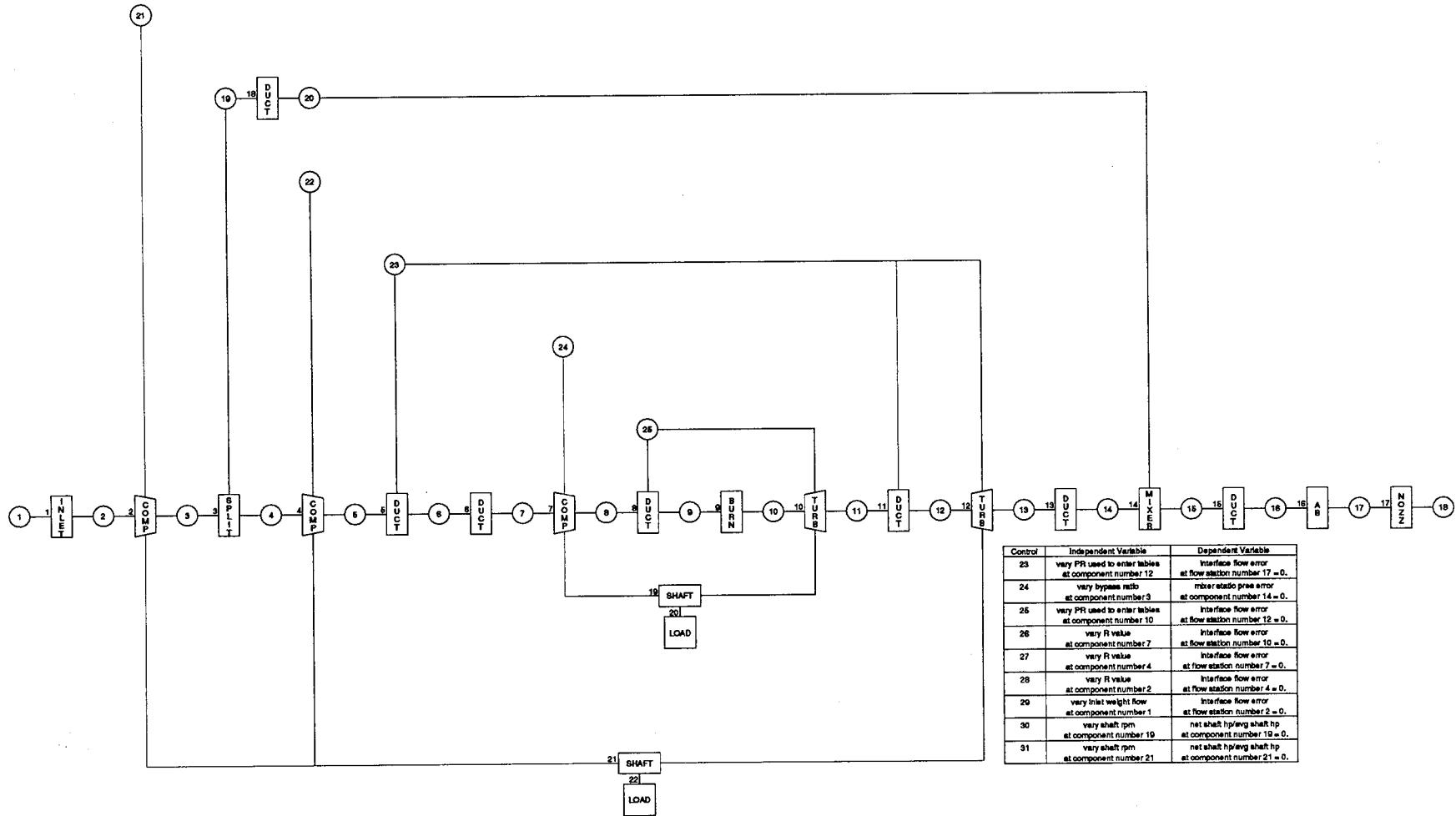


Figure B2. Default configuration 2.

### Dual-Rotor Turbofan—Default Configuration 3

This configuration (fig. B3) contains 30 components, including 9 controls. The low-pressure rotor drives a fan and a compressor and the high-pressure rotor drives a compressor. All bypass airflow passes through the low-pressure fan only and all the core flow passes through the fan and both compressors. The bypass airflow is discharged through a separate fan and nozzle and the core flow passes through the afterburner and the core nozzle. The default tables are on “DEFTAB,” and the default table reference numbers are as follows:

- 11      inlet pressure recovery (MIL-E-5007D)
- 701     referred flow (fan)
- 702     adiabatic efficiency (fan)
- 703     pressure ratio (fan)
- 701     referred flow (low-pressure compressor)
- 702     adiabatic efficiency (low-pressure compressor)
- 703     pressure ratio (low-pressure compressor)
- 701     referred flow (high-pressure compressor)
- 702     adiabatic efficiency (high-pressure compressor)
- 703     pressure ratio (high-pressure compressor)
- 121     referred flow (high-pressure turbine)
- 122     adiabatic efficiency (high-pressure turbine)
- 121     referred flow (low-pressure turbine)
- 112     adiabatic efficiency (low-pressure turbine)
- 111     referred flow schedule

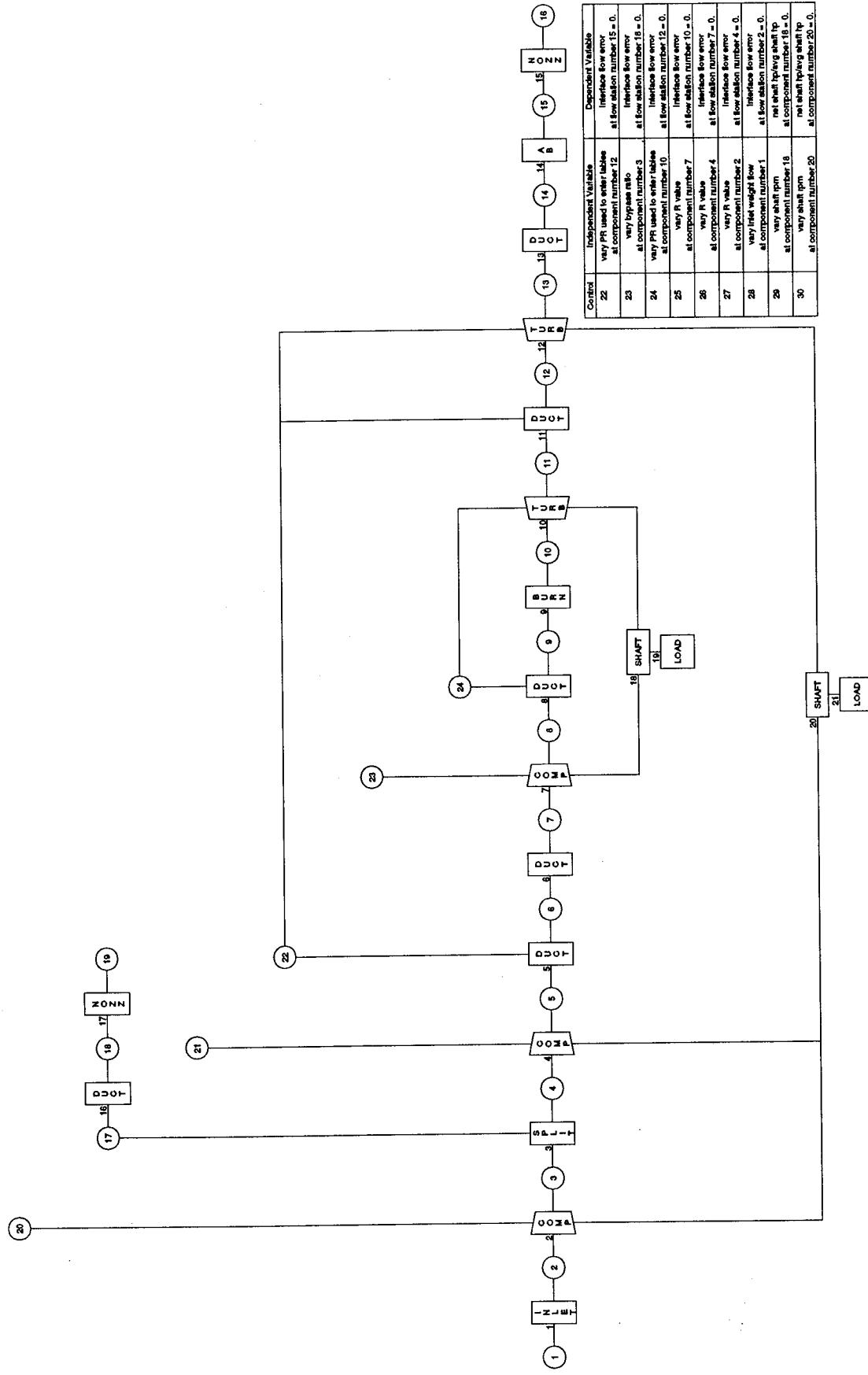


Figure B3. Default configuration 3.

#### **Dual-Rotor Turbojet—Default Configuration 4**

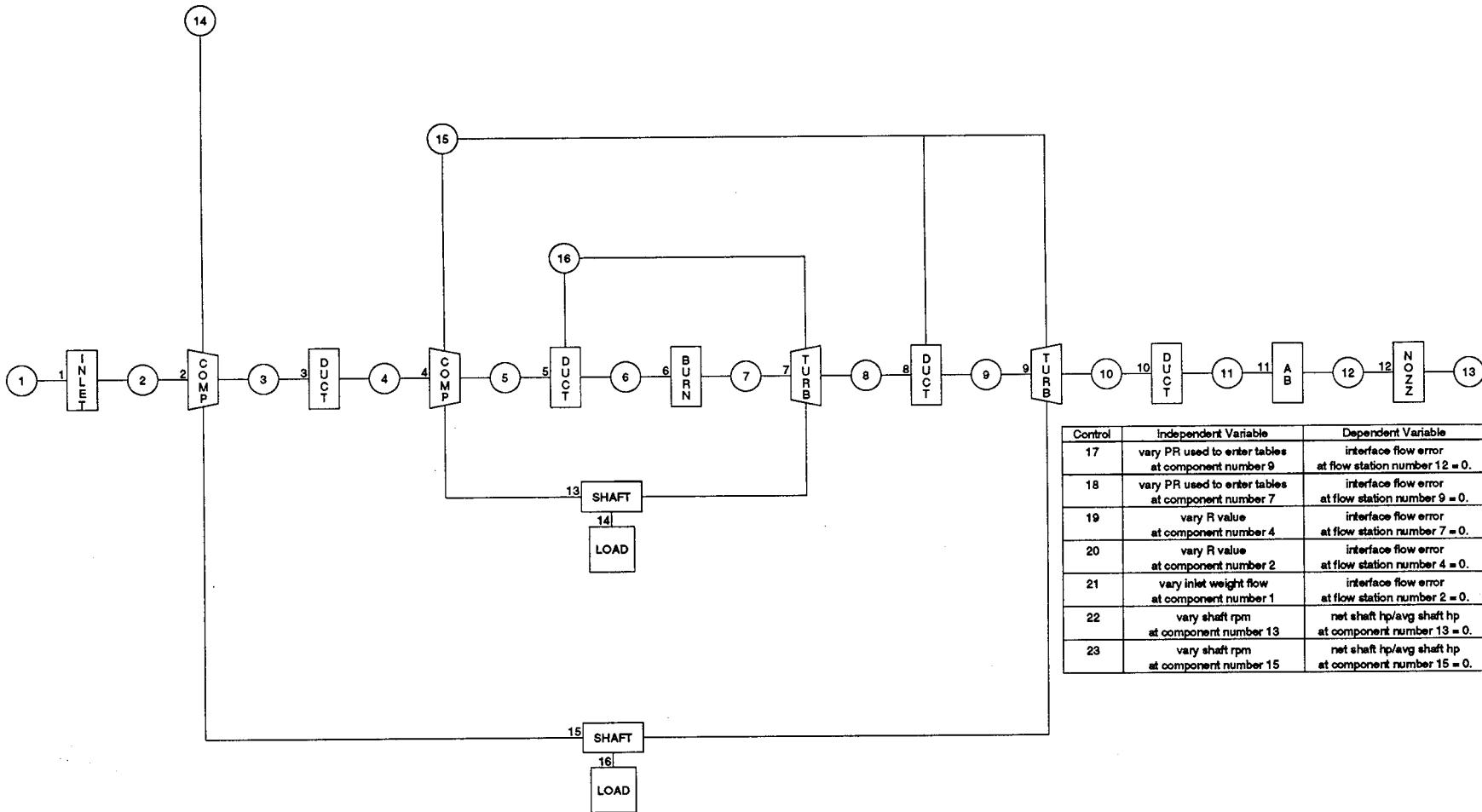
This configuration (fig. B4) contains 23 components, including 7 controls. The low-pressure rotor drives the low-pressure compressor and the high-pressure rotor drives the high-pressure compressor. Both compressor components are represented by the same component maps, as are both turbine components. The default tables are on “DEFTAB,” and the default table reference numbers are as follows:

- 11      inlet pressure recovery (MIL-E-5007D)
- 701     referred flow (low-pressure compressor)
- 702     adiabatic efficiency (low-pressure compressor)
- 703     pressure ratio (low-pressure compressor)
- 701     referred flow (high-pressure compressor)
- 702     adiabatic efficiency (high-pressure compressor)
- 703     pressure ratio (high-pressure compressor)
- 121     referred flow (high-pressure turbine)
- 122     adiabatic efficiency (high-pressure turbine)
- 121     referred flow (low-pressure turbine)
- 122     adiabatic efficiency (low-pressure turbine)
- 111     referred flow schedule

#### **Single-Shaft Turbojet—Default Configuration 5**

This configuration (fig. B5) contains 14 components, including 4 controls. The default tables are on “DEFTAB,” and the default table reference numbers are as follows:

- 11      inlet pressure recovery (MIL-E-5007D)
- 701     referred flow (compressor)
- 702     adiabatic efficiency (compressor)
- 703     pressure ratio (compressor)
- 121     referred flow (turbine)
- 122     adiabatic efficiency (turbine)
- 111     referred flow schedule



Control	Independent Variable	Dependent Variable
17	vary PR used to enter tables at component number 9	interface flow error at flow station number 12 = 0.
18	vary PR used to enter tables at component number 7	interface flow error at flow station number 9 = 0.
19	vary R value at component number 4	interface flow error at flow station number 7 = 0.
20	vary R value at component number 2	interface flow error at flow station number 4 = 0.
21	vary inlet weight flow at component number 1	interface flow error at flow station number 2 = 0.
22	vary shaft rpm at component number 13	net shaft hp/avg shaft hp at component number 13 = 0.
23	vary shaft rpm at component number 15	net shaft hp/avg shaft hp at component number 15 = 0.

Figure B4. Default configuration 4.

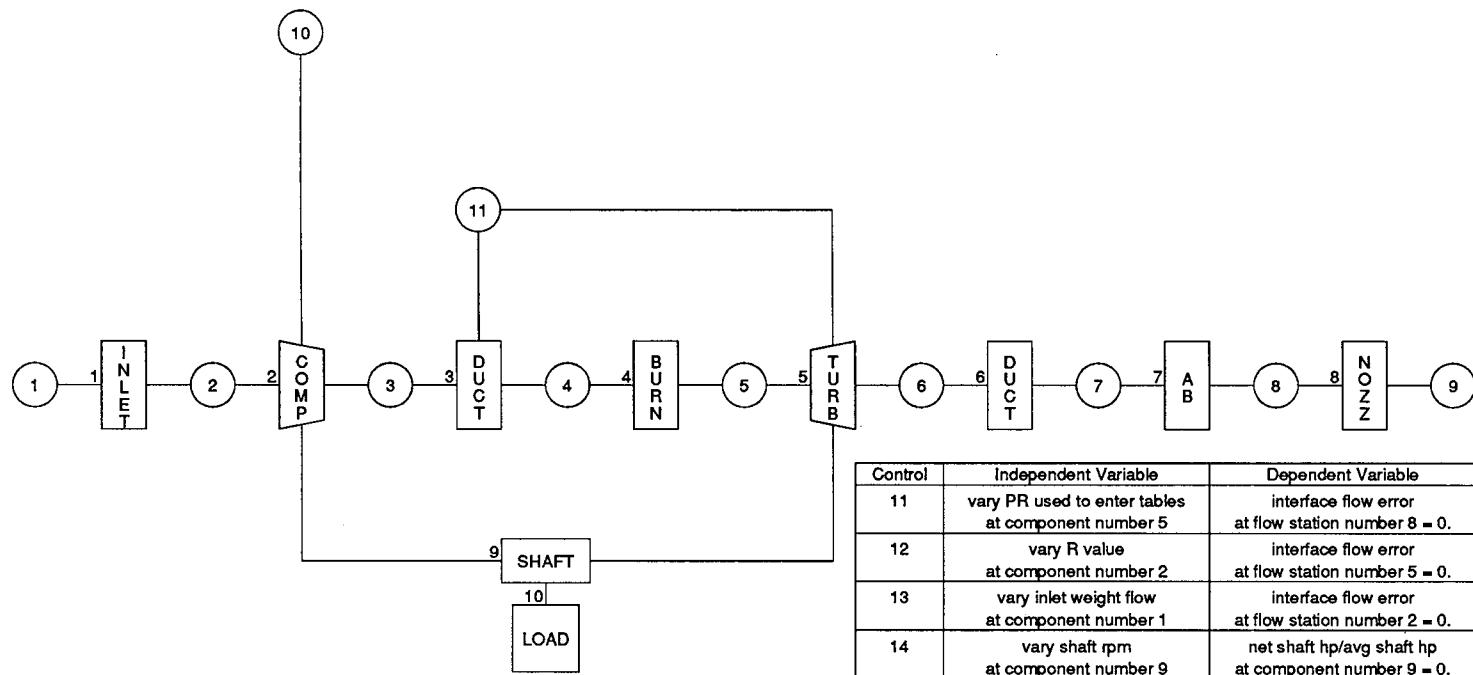


Figure B5. Default configuration 5.

## Dual-Rotor Turbofan—Default Configuration 6

This configuration (fig. B6) contains 29 components, including 8 controls. The low-pressure rotor drives a fan and the high-pressure rotor drives a compressor. All bypass airflow passes through the low-pressure fan only and all the core flow passes through both the fan and the compressor. The bypass airflow is discharged through a separate fan and nozzle and the core flow passes through the afterburner and the core nozzle. The default tables are on “DEFTAB,” and the default table reference numbers are as follows:

- 11      inlet pressure recovery (MIL-E-5007D)
- 701     referred flow (fan)
- 702     adiabatic efficiency (fan)
- 703     pressure ratio (fan)
- 701     referred flow (compressor)
- 702     adiabatic efficiency (compressor)
- 703     pressure ratio (compressor)
- 121     referred flow (high-pressure turbine)
- 122     adiabatic efficiency (high-pressure turbine)
- 121     referred flow (low-pressure turbine)
- 112     adiabatic efficiency (low-pressure turbine)
- 111     referred flow schedule

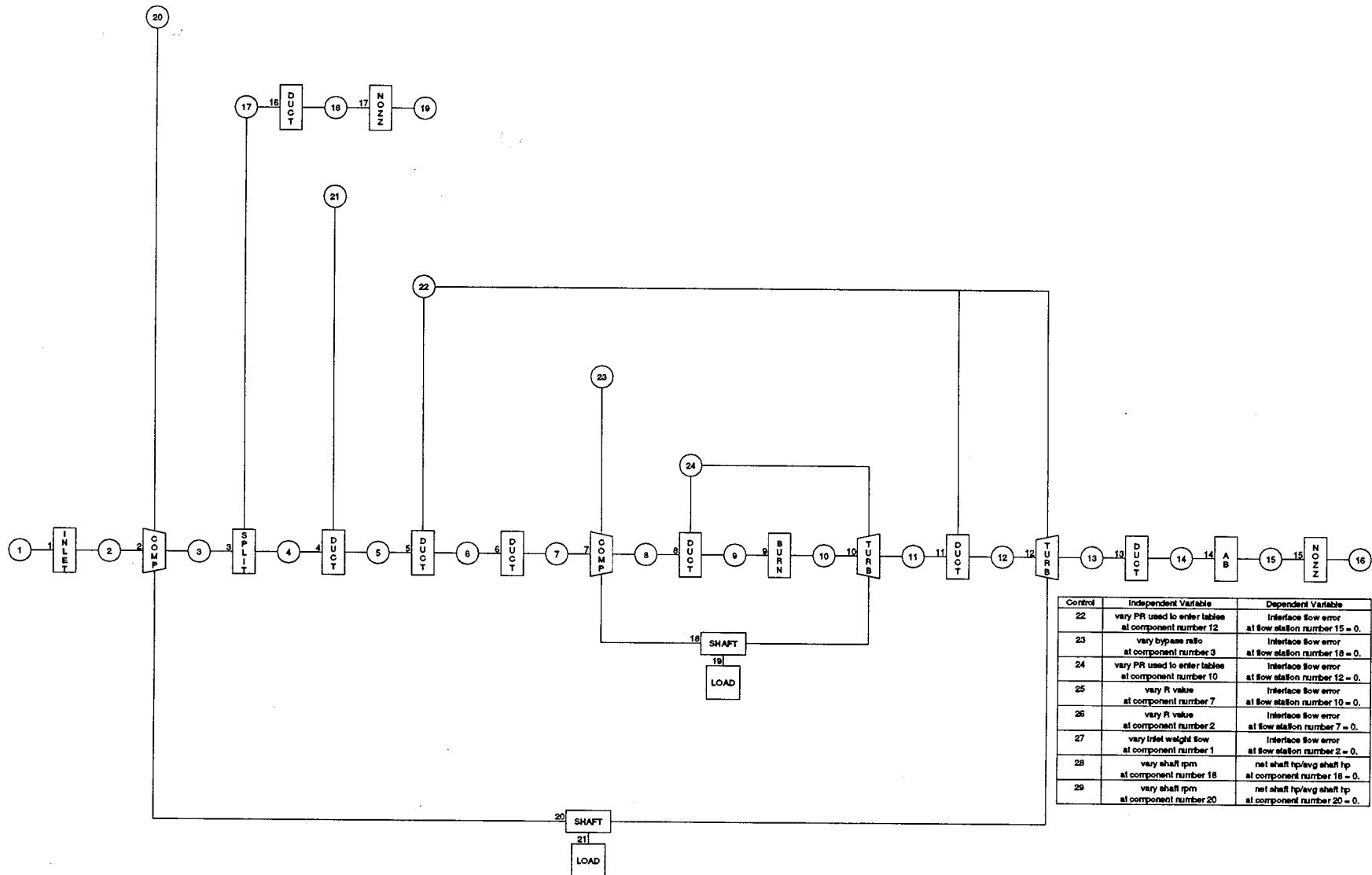


Figure B6. Default configuration 6.

### Ramjet—Default Configuration 7

This configuration (fig. B7) contains five components, including one control. The default tables are on "DEFTAB," and the default table reference numbers are as follows:

- 11      inlet pressure recovery (MIL-E-5007D)
- 111     referred flow schedule

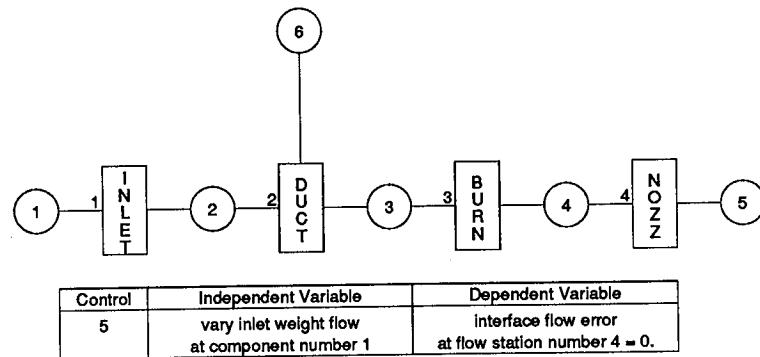


Figure B7. Default configuration 7.

## Appendix C

### QNEP and QDATGEN Options and Sample Problems

#### Command Line Options

Command line options are options, entered from the command line, that affect selected parameters within QNEP and QDATGEN. To see a list of these options the user can enter "QNEP ?" and the following QNEP options are written to the screen:

```
QNEP; PC version: 1.40
```

Command line options...

```
-I [input file name] -O [output file name] -R -D -A -B, -T=100, -N=50 -S  
...-AP allows interactively and automatically setting the path  
    where data is to be computed.  
...-R changes the output format for large nozzle pressure ratios.  
...-D turns the debug mode on - debug output file is "DEBUG"  
...-A causes data for ANOPP to be printed.  
...-U causes selected data to be printed.  
...-M causes data for the rotating components to be printed.  
    i.e. RPM, R, N/rT, Efficiency, and Pressure ratio- output files  
    are "TAPE7" for the compressors and "TAPE8" for the turbine.  
    The -M option must not be used when the -A option is used.
```

Press <ENTER> to Continue....

```
...-B suppresses Broyden's method of estimating derivatives.  
...-T allows the user to vary the amount the burner temperature is  
    reduced when WMAX is exceeded.  
...-N allows the user to vary the maximum number of iterations allowed.  
...-S causes the program to stop if the max # of iterations is exceeded.  
...-X suppresses output of NAMELIST and table data.  
...-C=n to swap control n and variable nozzle.  
...-TMIN=n causes TDEL for AB off to be set automatically.  
    TDEL is computed as (Tstart-TMIN)/NP-1. Tstart is the NAMELIST  
    input value or the computed value that satisfies the mass flow limit.  
...-PC to place a code based on throttle setting counter  
    inplace of the burner outlet temperature.
```

If -I or -O is used the file name must be included.  
Input defaults to "TAPE5" and output defaults to "TAPE6".  
The options can be in any order.

example: "QNEP -I INPUT.DAT -d -T=50"

Entering "QDATGEN ?" writes the following command line options associated with QDATGEN to the screen:

```
QDATGEN; PC version: 1.21
```

Command line options...

```
-O [output file name]  
Output defaults to "TAPE5".  
The options can be in any order.
```

example: "QNEP -O OUTPUT.DAT"

The “-I” and “-O” options allow the user to override the I/O default file names “TAPE5” and “TAPE6,” respectively. The current version of QDATGEN contains only one option that allows the user to change the default output file. The remaining options, all associated with QNEP, are described below in more detail.

The “-AP” option allows the user to interactively select the points where data are to be computed. QNEP can be set to run a full deck by selecting a minimum and a maximum dynamic pressure and an increment in Mach number and in altitude. QNEP can also be set to compute data along a constant-dynamic-pressure path, at a constant altitude, at a constant Mach number, or at individually selected Mach number-altitude combinations.

The “-R” option affects the format of the output data, specifically the nozzle area and the nozzle pressure ratio. When this option is selected, if the nozzle pressure ratio is  $\leq 100$ , the second format is used for nozzle area and pressure ratio. Otherwise the standard format is used:

...	T9	PR9	A9	RR	
...	F5.0	F6.2	F5.0	F5.3	...
...	F5.0	I6	I5	F5.3	...

The “-D” option causes information regarding the current location as well as some values of some key variables to be printed to file “DEBUG.” The file can become very large quickly, so it is important not to use this option if the available disk space is small or the QNEP input file is large. The following is a portion of such a file:

```

Call to FLOCAL complete. (SS=.14E-01)
Call to FLOCAL...
Call to INLET...
Call to INLET complete.
Call to COMPRS...
At entry point TABLU...
  X=0.2000E+01  Y=0.1001E+01  Z=0.0000E+00
Call to TABLU complete.  FXYZ=0.5374E+02
At entry point TABLU...
  X=0.2000E+01  Y=0.1001E+01  Z=0.0000E+00
Call to TABLU complete.  FXYZ=0.1442E+02
At entry point TABLU...
  X=0.2000E+01  Y=0.1001E+01  Z=0.0000E+00
Call to TABLU complete.  FXYZ=0.8699E+00
Call to function THERM...  ID = 4 - GET H FROM TEMP= 0.51867E+03,
Call to function THERM...  ID = 2 - GET RPR FROM TEMP= 0.51867E+03

```

The “-A” option prints data required by the Aircraft Noise Prediction Program (ANOPP). The data are printed to the file “anopp.dat” and are not in a format compatible with ANOPP and must therefore be preprocessed. Because the program uses unit 7 to write these data, this option is not compatible with the “-M” or “-U” options.

The “-U” option allows data customized for the individual user to be printed. Changes in the format or type of data to be printed are made in the subroutine “USEROUT.FOR.” Because the program uses unit 7 to write these data, this option is not compatible with the “-M” or “-A” options. The data are written to the file “USER.DAT.”

The “-M” option causes data for the rotating components to be printed, i.e., rpm,  $R$ -value,  $N/\sqrt{6}$  efficiency, and PR. Output files are “TAPE7” for the compressors and “TAPE8” for the turbines. When there is more than one component, the data are printed in the order that the components appear in the configuration.

"TAPE7" compressor data...

Mach	Altitude	BOT	RPM	"R"	N/rT	Eff	PR
0.00	0.	2800.0	1.077	3.458	1.090	0.803173	5.128
0.00	0.	2800.0	0.881	1.219	0.802	0.869916	7.494
0.00	0.	2700.0	0.971	3.278	0.982	0.809925	4.838
0.00	0.	2700.0	0.875	1.290	0.806	0.870580	7.514

"TAPE8" Turbine data...

Mach	Altitude	BOT	RPM	Table PR	N/rT	Eff	PR
0.00	0.	2800.0	0.881	2.874	98.493	0.900727	3.625
0.00	0.	2800.0	1.077	3.000	120.534	0.923221	2.090
0.00	0.	2700.0	0.875	2.948	99.632	0.900640	3.729
0.00	0.	2700.0	0.971	3.000	111.060	0.915169	2.090

The “-B” option suppresses Broyden’s method of estimating derivatives. This may or may not improve reliability and will most likely increase the execution time. This option is not recommended unless other efforts fail, and even then the effect will likely be insignificant.

The “-T” option allows the user to vary the amount the burner temperature is reduced when WMAX is exceeded. The default value is 100 and in most instances is recommended. If QNEP fails to converge, a smaller TDEL may help since the solution based on the first temperature is used as an initial guess for the next guess. On the other hand if the configuration is relatively simple (i.e., a turbojet or a ramjet) a larger  $\Delta T$  may improve QNEP performance in cases where the maximum temperature is substantially larger than the correct temperature. A larger  $\Delta T$  may also cause the algorithm to become unstable and prevent a solution from being found.

The “-N” option allows the user to vary the maximum number of iterations allowed. In many cases the necessary number of iterations is much less than the default maximum of 50. As a result this option can save computation time that would likely be wasted anyway. In very few instances will more than 50 iterations be required.

The “-S” option causes the program to stop if the maximum number of iterations is exceeded. If QNEP fails to converge on one point it will normally continue on to the next point. However, it is often the case that when one point fails the next point is likely to fail. This option can save a lot of time in attempting to generate such data points. It is generally recommended that this option be used on the first run of a newly generated configuration because, if for example a required control was omitted or a design point control was not turned off, QNEP will continue to attempt to generate point after point until all the NAMELIST input data have been read in.

The “-X” option suppresses the output of the NAMELIST input and table data. This option can be especially useful where disk space is limited or where disk access time is slow.

The “-C=n” option can be used to swap between control component number “n” and a variable nozzle. This option is generally used when both afterburner and nonafterburner cases are being run. For dry operation the control component number “n” is used to resolve the flow error at the nozzle, and for augmented operation this control is automatically switched off and the nozzle area is allowed to vary (CDAT(7,J) for the nozzle is switched to 1).

The “-TMIN=T” option allows TDEL to vary based on a minimum burner temperature  $T$  and the maximum burner temperature as input or as computed. TDEL is computed as:

$$TDEL = \frac{T_{start} - T}{NP - 1}$$

where  $T_{start}$  is the maximum burner outlet temperature that satisfies the mass-flow limit or the maximum allowable burner outlet temperature as input.

The “-PC” option places a code based on the throttle setting counter in place of the burner outlet temperature in the standard output file. If 7 throttle points are requested the power code varies from 10 to 4 for dry operation and from 20 to 14 for augmented operation, provided that the burner outlet

temperature is decreasing for each point. This option was added to ease the conversion from QNEP output to performance code input.

### Sample Problem 1—User-Specified Configuration

#### *QDATGEN Terminal Session*

To run QDATGEN simply type “QDATGEN.” The following is a sample terminal session used to generate the QNEP input for a regenerative turboshaft configuration (fig. C1). Because no such engine exists in the default data base, option 0, “User specified engine,” is used. Off-design point input data are generated for Mach number and altitude combinations between 100 and 1500 psf at increments in Mach number of 0.2 and in altitude of 10 000 ft. The maximum allowable Mach number is 1.2 and the maximum allowable altitude is 40 000 ft. Additional points at low dynamic pressure are also generated. In order to improve QNEP reliability the QNEP input data are cycled from low Mach number to high Mach number and back to low Mach number for each successive altitude.

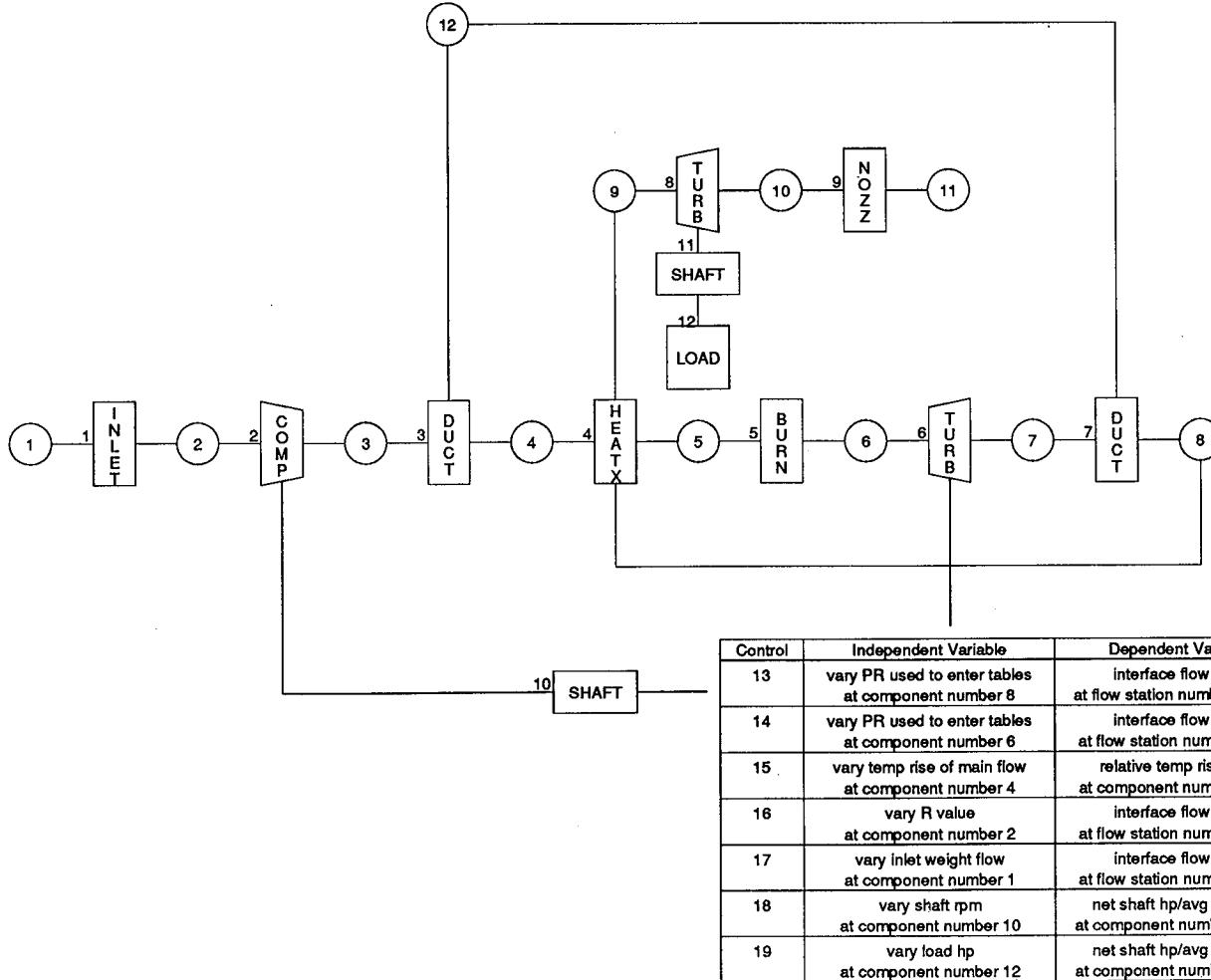


Figure C1. Regenerative turboshaft configuration for sample problem 1.

QDATGEN: PC version: 1.21

This program allows the interactive generation of an input file written in namelist format, for use in QNEP, a special version of NEPCOMP II. The user should already be familiar with QNEP and should have a schematic diagram of the engine to be modeled on hand.

The QDATGEN output file will default to "TAPE5" ....  
the default can be changed from the command line by entering  
QDATGEN -O [filename].

Press Enter to Continue.

Select engine to be modeled...

- 1 = Modify an existing design point namelist input.
- 0 = User specified engine.
- 1 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through the lp rotor.
- 2 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through a lp fan only.  
This engine requires 3 compressor components.
- 3 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through a lp fan to a fan nozzle.  
This engine requires 3 compressor components.
- 4 = Dual-rotor turbojet with or without afterburning.
- 5 = Single-rotor turbojet with or without afterburning.
- 6 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through a lp fan to a fan nozzle.  
This engine requires 2 compressor components.
- 7 = Ramjet

>>0

This program allows the interactive generation of an input file, TAPE2 written in namelist format, for use in qnep, a special version of NEPCOMP II. The user should already be familiar with qnep and should have a schematic diagram of the engine to be modeled on hand. The diagram should include all components and flow stations appropriately numbered. For the initial setup all numerical inputs default to zero unless otherwise indicated. Once a value has been entered that value becomes the default value for the particular input variable. A table data deck must be available for non-dimensional referred flow limit vs Theta T2. Other table data decks must be available as required. If all table data decks are in one file, the flow schedule must be the first table to appear in that file. Table data decks and pertinent information should be entered during the initial input phase even though they may not be needed for the first calculation. For more information see nadc report no. NADC-80XXX-60.

The following is a list of possible configuration components and their corresponding numerical codes.

Press Enter to Continue.

CODE	COMPONENT
1	- Inlet
2	- Duct, Burner, or A/B
4	- Compressor

5	-	Turbine
6	-	Heat exchanger
7	-	Splitter
8	-	Mixer
9	-	Nozzle
10	-	Load
11	-	Shaft
12	-	Control
13	-	Optimization variable
14	-	Limit variable

Press Enter to Continue.

The following is a list of possible data tables...

INLET - 1) Drag  $D/(q*SF)$  vs  $A_0/A_{ref}$  or referred flow for various Mach numbers.

2) Inlet recovery vs referred flow for various Mach numbers.

DUCT - 1) Delta-P/P vs corrected flow.

BURNER - 1) Delta-P/P vs corrected flow.

2) Efficiency vs corrected flow for various fuel:air ratios.

3) Fuel heating value vs bot for various inlet pressures.

COMPRESSOR - 1) Referred flow vs "R" for various referred speeds.

2) Efficiency vs "R" and referred speed.

3) Pressure ratio vs "R" and referred speed.

Press Enter to Continue.

TURBINE - 1) Referred flow vs pressure ratio for various referred speeds.

2) Efficiency vs pressure ratio and referred speed.

HEAT EXCHG - 1) Delta-P/P vs corrected flow (primary stream).

2) Delta-P/P vs corrected flow (secondary).

3) Effectiveness vs cold side mass flow for various hot:cold mass flow ratios.

SPLITTER - 1) Delta-P/P vs corrected flow (primary stream).

2) Delta-P/P vs corrected flow (secondary).

NOZZLE - 1) Nozzle flow coefficient vs pressure ratio (total:ambient).

2) Aftend drag  $D/(q*SF)$  vs pressure ratio for various mach numbers.

OR

Aftend drag  $D/(q*SF)$  vs mach number for various exit:design throat area ratios.

3) Thrust coefficient vs pressure ratio for various exit:design throat area ratios.

4) Exit:design throat area ratio vs throat:design throat area ratio.

Press Enter to Continue.

Enter the total number of simulation components (MAX=40).

>>19

Enter the total number of flow stations (MAX=44).

>>12

Enter the code for component 1

>>1

Component number 1 is a Inlet

Enter the station number where the main flow enters the Inlet

>>1

Enter the station number where the main flow exits the Inlet

>>2

Enter the code for component 2

>>4

Component number 2 is a Compressor

Enter the station number where the main flow enters the Compressor

>>2

Enter the station number where the main flow exits the Compressor

>>3

Enter the station number where the bleed flow exits the Compressor  
>>0

Enter the code for component 3  
>>2

Component number 3 is a Duct, Burner, or A/B

Enter the station number where the main flow enters the Duct, Burner, or A/B

>>3

Enter the station number where the main flow exits the Duct, Burner, or A/B

>>4

Enter the station number where the bleed flow enters the  
Duct, Burner, or A/B

>>0

Enter the station number where the bleed flow exits the Duct, Burner, or A/B

>>12

Enter the code for component 4

>>6

Component number 4 is a Heat exchanger

Enter the station number where the main flow enters the Heat exchanger  
Main flow = the stream receiving heat.

>>4

Enter the station number where the main flow exits the Heat exchanger

>>5

Enter the flow station number of the secondary or cross flow  
(flow that releases heat).

>>8

Enter the flow station where the stream releasing heat exits the  
heat exchanger.

>>9

Enter the code for component 5

>>2

Component number 5 is a Duct, Burner, or A/B

Enter the station number where the main flow enters the Duct, Burner, or A/B

>>5

Enter the station number where the main flow exits the Duct, Burner, or A/B

>>6

Enter the station number where the bleed flow enters the  
Duct, Burner, or A/B

>>0

Enter the station number where the bleed flow exits the Duct, Burner, or A/B

>>0

Enter the code for component 6

>>5

Component number 6 is a Turbine

Enter the station number where the main flow enters the Turbine

>>6

Enter the station number where the main flow exits the Turbine

>>7

Enter the station number where the bleed flow enters the  
Turbine

>>0

Enter the code for component 7

>>2

Component number 7 is a Duct, Burner, or A/B

Enter the station number where the main flow enters the Duct, Burner, or A/B

>>7

Enter the station number where the main flow exits the Duct, Burner, or A/B

>>8

Enter the station number where the bleed flow enters the  
Duct, Burner, or A/B

>>12

Enter the station number where the bleed flow exits the Duct, Burner, or A/B

>>0

Enter the code for component 8

>>5

Component number 8 is a Turbine

Enter the station number where the main flow enters the Turbine

>>9

Enter the station number where the main flow exits the Turbine

>>10

Enter the station number where the bleed flow enters the  
Turbine

>>0

Enter the code for component 9

>>9

Component number 9 is a Nozzle

Do you want only to set input for afterburning mode (Y/N) ?

>>n

Enter the station number where the main flow enters the Nozzle

>>10

Enter the station number where the main flow exits the Nozzle

>>11

Enter the code for component 10

>>11

Component number 10 is a Shaft

Enter the component number of the first component connected to this  
Shaft (compressor, turbine, load, or another shaft).

>>2

Enter the component number of the second component connected to  
this shaft.

>>6

Enter the component number of the third component connected to this  
shaft.

>>0

Enter the code for component 11

>>11

Component number 11 is a Shaft

Enter the component number of the first component connected to this  
Shaft (compressor, turbine, load, or another shaft).

>>8

Enter the component number of the second component connected to  
this shaft.

>>12

Enter the component number of the third component connected to this  
shaft.

>>0

Enter the code for component 12

>>10

Component number 12 is a Load

Enter the code for component 13

>>12

Component number 13 is a Control

Enter either the flow station number or the component number where  
the control dependent variable is located (or zero).

- Flow station if the control dependent variable is a station  
property output.
- Component number if the control dependent variable is a "DATOUT" variable.
- Zero if the control dependent variable is a performance property.

>>10

Enter the component number where the control independent variable  
is located. Independent variable may only be one of the "CDAT" input  
variables.

>>8

Enter the code for component 14

>>12

Component number 14 is a Control

Enter either the flow station number or the component number where  
the control dependent variable is located (or zero).

- Flow station if the control dependent variable is a station  
property output.
- Component number if the control dependent variable is a "DATOUT" variable.
- Zero if the control dependent variable is a performance property.

>>9

Enter the component number where the control independent variable  
is located. Independent variable may only be one of the "CDAT" input  
variables.

>>6

Enter the code for component 15

>>12

Component number 15 is a Control

Enter either the flow station number or the component number where  
the control dependent variable is located (or zero).

- Flow station if the control dependent variable is a station  
property output.
- Component number if the control dependent variable is a "DATOUT" variable.
- Zero if the control dependent variable is a performance property.

>>4

Enter the component number where the control independent variable  
is located. Independent variable may only be one of the "CDAT" input  
variables.

>>4

Enter the code for component 16

>>12

Component number 16 is a Control

Enter either the flow station number or the component number where  
the control dependent variable is located (or zero).

- Flow station if the control dependent variable is a station  
property output.
- Component number if the control dependent variable is a "DATOUT" variable.
- Zero if the control dependent variable is a performance property.

>>6

```

Enter the component number where the control independent variable
is located. Independent variable may only be one of the "CDAT" input
variables.
>>2

Enter the code for component 17
>>12

Component number 17 is a Control

Enter either the flow station number or the component number where
the control dependent variable is located (or zero).
-Flow station if the control dependent variable is a station
property output.
-Component number if the control dependent variable is a "DATOUT" variable.
-Zero if the control dependent variable is a performance property.
>>2
Enter the component number where the control independent variable
is located. Independent variable may only be one of the "CDAT" input
variables.
>>1

Enter the code for component 18
>>12

Component number 18 is a Control

Enter either the flow station number or the component number where
the control dependent variable is located (or zero).
-Flow station if the control dependent variable is a station
property output.
-Component number if the control dependent variable is a "DATOUT" variable.
-Zero if the control dependent variable is a performance property.
>>10
Enter the component number where the control independent variable
is located. Independent variable may only be one of the "CDAT" input
variables.
>>10

Enter the code for component 19
>>12

Component number 19 is a Control

Enter either the flow station number or the component number where
the control dependent variable is located (or zero).
-Flow station if the control dependent variable is a station
property output.
-Component number if the control dependent variable is a "DATOUT" variable.
-Zero if the control dependent variable is a performance property.
>>11
Enter the component number where the control independent variable
is located. Independent variable may only be one of the "CDAT" input
variables.
>>12

Component number 1 is a Inlet

Enter the inlet weight flow (lbs/sec).
>>225
Enter the altitude (enter -1 to specify free stream static temperature
and pressure.
>>0
Enter the inlet drag (d/q/sf) or table reference number.
>>0
Select one: 0 - Geometric altitude is specified.
           1 - Geopotential altitude is specified.
>>0
Enter the inlet free stream mach number.

```

```

>>0
Enter the inlet pressure recovery or table reference number
  (enter zero for AIAA recovery).
>>1
Is there a table for inlet pressure recovery (Y/N) ?
>>Y
Enter the maximum permitted referred flow used to enter recovery table.
>>100
Enter the scale factor on referred flow used to enter recovery table.
>>1
Enter the free stream fuel/air ratio.
>>0
Is there a table for inlet drag (Y/N) ?
>>N
Are the CDAT inputs correct up to this point (Y/N) ?
>>Y

```

Component number 2 is a Compressor

```

Are there compressor tables (Y/N) ?
>>Y
Enter R value used to enter tables.
>>2
Enter scalar multiplier on value of referred speed used to enter the
tables.
>>1
Enter the fraction of compressor inlet flow exiting as bleed flow.
>>0
Enter referred flow at compressor inlet or table reference number.
>>701
Enter scalar multiplier on value of referred flow.
>>1
Enter the adiabatic efficiency or table reference number.
>>702
Enter scalar multiplier on value of adiabatic efficiency.
>>1
Enter the compressor pressure ratio or table reference number.
>>703
Enter scalar multiplier on pressure ratio.
Defined as [PRactual-1]/[PRtable(or input)-1].
>>1
Enter value of third argument when variable geometry characteristics
are used.
>>0
Enter the fractional bleed horsepower loss due to inner stage bleeding.
>>0
Enter the design point adiabatic efficiency.
>>.87
Enter the design point pressure ratio.
>>12
Enter the design point referred speed used to enter tables.
>>1
Are the CDAT inputs correct up to this point (Y/N) ?
>>

```

Component number 3 is a Duct, Burner, or A/B

```

Enter the delta p/p (.Lt.1) Or table reference number
>>.05
Enter the corrected flow squared coefficient used as an adder to the
pressure drop.
>>0
Is the component a duct (Y/N) ?
>>Y
Enter the fraction of total available bleed flow entering the duct
secondary inlet.
>>0
Enter the fraction of main exit flow directed to secondary bleed flow
exit from duct.
>>.05
Are the CDAT inputs correct up to this point (Y/N) ?
>>

```

Component number 4 is a Heat exchanger

Enter the delta p/p (.Lt.1) Or table reference number for main flow stream (stream receiving heat).  
>>.05  
Enter the delta p/p (.Lt.1) Or table reference number for secondary flow stream (stream releasing heat).  
>>.05  
Enter the temperature rise of main flow stream (guess value).  
>>1500  
Enter the heat exchanger effectiveness or table reference number.  
>>.9  
Enter scalar multiplier on value of heat exchanger effectiveness.  
>>1  
Are the CDAT inputs correct up to this point (Y/N) ?  
>>

Component number 5 is a Duct, Burner, or A/B

Enter the delta p/p (.Lt.1) Or table reference number  
>>.05  
Enter the corrected flow squared coefficient used as an adder to the pressure drop.  
>>0  
Is the component a duct (Y/N) ?  
>>N  
Enter the burner efficiency or table reference number.  
>>.95  
Enter the design point afterburner mach number used to compute area. For rayleigh line momentum pressure drop. (Enter zero for no momentum pressure drop.)  
>>0  
Enter the burner outlet temperature, R.  
>>3200  
Enter the fuel heating value, btu/lbm, or table reference number.  
>>18500  
Are the CDAT inputs correct up to this point (Y/N) ?  
>>

Component number 6 is a Turbine

Are there turbine tables (Y/N) ?  
>>Y  
Enter the pressure ratio (.Gt.1) Used to enter tables  
>>3  
Enter scalar multiplier on value of referred speed used to enter the tables.  
>>1  
Enter the fraction of the total available bleed flow that is entering the turbine.  
>>0  
Enter referred flow at turbine inlet or table reference number.  
>>121  
Enter scalar multiplier on value of referred flow.  
>>1  
Enter the adiabatic efficiency or table reference number.  
>>122  
Enter scalar multiplier on value of adiabatic efficiency.  
>>1  
Enter scalar multiplier on pressure rise ratio.  
Defined as [PRactual-1]/[PRtable(or input)-1].  
>>1  
Enter value of third argument when variable geometry characteristics are used.  
>>63  
Enter the fraction of total turbine bleed flow entering the front of the turbine.  
>>0  
Enter the design point adiabatic efficiency.  
>>.92  
Enter the turbine horsepower split factor. (usually 1)  
>>1

Enter the design point referred speed used to enter tables.

>>100

Are the CDAT inputs correct up to this point (Y/N) ?

>>

Component number 7 is a Duct, Burner, or A/B

Enter the delta p/p (.Lt.1) Or table reference number

>>.02

Enter the corrected flow squared coefficient used as an adder to the pressure drop.

>>0

Is the component a duct (Y/N) ?

>>Y

Enter the fraction of total available bleed flow entering the duct secondary inlet.

>>1

Enter the fraction of main exit flow directed to secondary bleed flow exit from duct.

>>0

Are the CDAT inputs correct up to this point (Y/N) ?

>>

Component number 8 is a Turbine

Are there turbine tables (Y/N) ?

>>Y

Enter the pressure ratio (.Gt.1) Used to enter tables

>>3

Enter scalar multiplier on value of referred speed used to enter the tables.

>>1

Enter the fraction of the total available bleed flow that is entering the turbine.

>>0

Enter referred flow at turbine inlet or table reference number.

>>121

Enter scalar multiplier on value of referred flow.

>>1

Enter the adiabatic efficiency or table reference number.

>>122

Enter scalar multiplier on value of adiabatic efficiency.

>>1

Enter scalar multiplier on pressure rise ratio.

Defined as [PRactual-1]/[PRtable(or input)-1].

>>1

Enter value of third argument when variable geometry characteristics are used.

>>63

Enter the fraction of total turbine bleed flow entering the front of the turbine.

>>0

Enter the design point adiabatic efficiency.

>>.92

Enter the turbine horsepower split factor. (usually 1)

>>1

Enter the design point referred speed used to enter tables.

>>100

Are the CDAT inputs correct up to this point (Y/N) ?

>>

Component number 9 is a Nozzle

Do you want only to set input for afterburning mode (Y/N) ?

>>n

Enter the nozzle throat flow area (in\*in).

>>300

Enter the nozzle flow coefficient or table reference number.  
(Wactual/Wideal).

>>.98

```

Enter the aftend drag (D/q/SF) or table reference number.
>>0
Enter one: -Enter zero to specify ambient exit static pressure.
            -Enter component reference number of inlet component
            to set nozzle exit pressure to inlet ambient pressure.

>>1
Is there a table for nozzle drag (Y/N) ?
>>N
Is there a table for nozzle velocity (or thrust coefficient) (Y/N) ?
>>N
Enter the nozzle velocity (or thrust coefficient).

>>.98
Select one: 0 - Nozzle is convergent.
            1 - Nozzle is C-D with full expansion to ambient.

>>0
Select one: 0 - Afterburner off [CDAT(7,J)].
            1 - Nozzle area is computed to match flow conditions.

NOTE: For variable area nozzle the control effecting the interface
      relative flow error upstream of the core nozzle should be turned
      off since this error is automatically eliminated by varying the
      throat area.

>>0
Are the CDAT inputs correct up to this point (Y/N) ?
>>
Component number 10 is a Shaft

Enter the shaft R.P.M., Actual.

>>1
Enter the gear ratio, R.P.M. Of first connected component / actual.
shaft R.P.M.

>>1
Enter the mechanical efficiency of first connected component.
(h.P.Output) / (h.P.Input).

>>1
Enter the gear ratio, R.P.M. Of second connected component / actual.
shaft R.P.M.

>>1
Enter the mechanical efficiency of second connected component.
(h.P.Output) / (h.P.Input).

>>1
Enter the gear ratio, R.P.M. Of third connected component / actual.
shaft R.P.M.

>>0
Are the CDAT inputs correct up to this point (Y/N) ?
>>

```

```

Component number 11 is a Shaft

Enter the shaft R.P.M., Actual.

>>1
Enter the gear ratio, R.P.M. Of first connected component / actual.
shaft R.P.M.

>>1
Enter the mechanical efficiency of first connected component.
(h.P.Output) / (h.P.Input).

>>1
Enter the gear ratio, R.P.M. Of second connected component / actual.
shaft R.P.M.

>>1
Enter the mechanical efficiency of second connected component.
(h.P.Output) / (h.P.Input).

>>1
Enter the gear ratio, R.P.M. Of third connected component / actual.
shaft R.P.M.

>>0
Are the CDAT inputs correct up to this point (Y/N) ?
>>

```

Component number 12 is a Load

Enter the load horsepower or table reference number  
(positive = work added to the system).  
>>-250  
Do you want this load (12) absolute hp to be summed in the overall  
performance summary (Y/N) ?  
>>N  
Are the CDAT inputs correct up to this point (Y/N) ?  
>>

Component number 13 is a Control

Is this control active (Y/N) ?  
>>N  
Enter the desired tolerance (DEFAULT=.001).  
>>  
Enter the minimum value of the independent variable (enter zero for  
no limit).  
>>0  
Enter the maximum value (zero for no limit).  
>>0  
Which CDAT variable is the independent variable for the Turbine  
designated by component number 8 for this control variable.  
1 - Pressure ratio used to enter tables  
2 - Fraction of bleed flow entering the turbine  
3 - Scalar multiplier on referred speed  
4 - Referred flow  
5 - Scale factor on referred flow  
6 - Adiabatic efficiency  
7 - Scale factor on adiabatic efficiency  
8 - Scalar multiplier on pressure ratio  
9 - Fraction of bleed entering the front  
10 - Value of third argument  
11 - Design point adiabatic efficiency  
12 - Design point referred speed  
13 - Turbine horsepower split factor

>>1  
Is the control dependent variable a flow station output (Y/N) ?  
>>Y

The dependent variable of control, located at flow station number 10, is:  
1 - Weight flow (lbs/sec).  
2 - Total pressure (psi).  
3 - Total temperature (R).  
4 - Fuel:air ratio.  
5 - Referred flow.  
6 - Mach number.  
7 - Static pressure (psi).  
8 - Interface relative flow error.

>>8  
Enter the desired value of the control dependent variable.  
>>0  
Are the CDAT inputs correct up to this point (Y/N) ?  
>>

Component number 14 is a Control

Is this control active (Y/N) ?  
>>N  
Enter the desired tolerance (DEFAULT=.001).  
>>  
Enter the minimum value of the independent variable (enter zero for  
no limit).  
>>  
Enter the maximum value (zero for no limit).  
>>  
Which CDAT variable is the independent variable for the Turbine  
designated by component number 6 for this control variable.  
1 - Pressure ratio used to enter tables  
2 - Fraction of bleed flow entering the turbine

```

3 - Scalar multiplier on referred speed
4 - Referred flow
5 - Scale factor on referred flow
6 - Adiabatic efficiency
7 - Scale factor on adiabatic efficiency
8 - Scalar multiplier on pressure ratio
9 - Fraction of bleed entering the front
10 - Value of third argument
11 - Design point adiabatic efficiency
12 - Design point referred speed
13 - Turbine horsepower split factor

>>1
Is the control dependent variable a flow station output (Y/N) ?
>>Y
The dependent variable of control, located at flow station number 9, is:
1 - Weight flow (lbs/sec).
2 - Total pressure (psi).
3 - Total temperature (R).
4 - Fuel:air ratio.
5 - Referred flow.
6 - Mach number.
7 - Static pressure (psi).
8 - Interface relative flow error.

>>8
Enter the desired value of the control dependent variable.
>>0
Are the CDAT inputs correct up to this point (Y/N) ?
>>

Component number 15 is a Control

Is this control active (Y/N) ?
>>N
Enter the desired tolerance (DEFAULT=.001).
>>
Enter the minimum value of the independent variable (enter zero for
no limit).
>>
Enter the maximum value (zero for no limit).
>>
Which CDAT variable is the independent variable for the Heat exchanger
designated by component number 4 for this control variable.
1 - Delta p/p, main flow stream
2 - Delta p/p, secondary flow stream
3 - Temperature rise of main flow
4 - Heat exchanger effectiveness
5 - Scale factor on heat exchanger effectiveness

>>3
Is the control dependent variable a flow station output (Y/N) ?
>>N
The dependent variable of control located at the Heat exchanger
designated by component number 4 is:
1 - Delta p/p, main flow stream
2 - Delta p/p, secondary flow stream
3 - Not used
4 - Heat exchanger effectiveness
5 - Scale factor on heat exchanger effectiveness
6 - Temperature rise across main flow stream
7 - Temperature rise ratio
8 - Relative temperature rise error

>>8
Enter the desired value of the control dependent variable.
>>0
Are the CDAT inputs correct up to this point (Y/N) ?
>>Component number 16 is a Control
Is this control active (Y/N) ?
>>N
Enter the desired tolerance (DEFAULT=.001).
>>
Enter the minimum value of the independent variable (enter zero for
no limit).
>>

```

```

Enter the maximum value (zero for no limit).
>>
Which CDAT variable is the independent variable for the Compressor
designated by component number  2 for this control variable.
    1 - "R" value
    2 - Fraction of main flow leaving as bleed flow
    3 - Scalar multiplier on referred speed
    4 - Referred flow used to enter tables
    5 - Scale factor on referred flow
    6 - Adiabatic efficiency
    7 - Scale factor on adiabatic efficiency
    8 - Compressor pressure ratio
    9 - Scalar multiplier on pressure ratio
   10 - Value of third argument
   11 - Fractional bleed horsepower loss
   12 - Design point adiabatic efficiency
   13 - Design point pressure ratio
   14 - Design point referred speed
>>1
Is the control dependent variable a flow station output (Y/N) ?
>>Y
The dependent variable of control, located at flow station number  6, is:
    1 - Weight flow (lbs/sec).
    2 - Total pressure (psi).
    3 - Total temperature (R).
    4 - Fuel:air ratio.
    5 - Referred flow.
    6 - Mach number.
    7 - Static pressure (psi).
    8 - Interface relative flow error.
>>8
Enter the desired value of the control dependent variable.
>>0
Are the CDAT inputs correct up to this point (Y/N) ?
>>

Component number 17 is a Control

Is this control active (Y/N) ?
>>N
Enter the desired tolerance (DEFAULT=.001).
>>
Enter the minimum value of the independent variable (enter zero for
no limit).
>>
Enter the maximum value (zero for no limit).
>>
Which CDAT variable is the independent variable for the Inlet
designated by component number  1 for this control variable.
    1 - Inlet weight flow, lbs/sec
    2 - Freestream static temperature, R
    3 - Freestream static pressure, psi
    4 - Inlet drag D/(q*SP)
    5 - Inlet freestream Mach number
    6 - Pressure recovery
    7 - Maximum permitted referred flow
    8 - Scale factor on referred flow
    9 - Altitude as input, ft.
   10 - Freestream fuel:air ratio
   11 - Switch
   12 - Reference area, in*in
   13 - Scale factor on inlet drag
>>1
Is the control dependent variable a flow station output (Y/N) ?
>>Y
The dependent variable of control, located at flow station number  2, is:
    1 - Weight flow (lbs/sec).
    2 - Total pressure (psi).
    3 - Total temperature (R).
    4 - Fuel:air ratio.
    5 - Referred flow.
    6 - Mach number.

```

```

    7 - Static pressure (psi).
    8 - Interface relative flow error.

>>8
    Enter the desired value of the control dependent variable.
>>0
    Are the CDAT inputs correct up to this point (Y/N) ?
>>

Component number 18 is a Control

Is this control active (Y/N) ?
>>N
    Enter the desired tolerance (DEFAULT=.001).
>>
    Enter the minimum value of the independent variable (enter zero for
    no limit).
>>
    Enter the maximum value (zero for no limit).
>>
    Which CDAT variable is the independent variable for the Shaft
    designated by component number 10 for this control variable.
        1 - Actual shaft speed, R.P.M.
        2 - Gear ratio of first connected component
        3 - Mechanical efficiency of the first component
        4 - Gear ratio of second connected component
        5 - Mechanical efficiency of the second component
        6 - Gear ratio of third connected component
        7 - Mechanical efficiency of the third component
        8 - Gear ratio of fourth connected component
        9 - Mechanical efficiency of the fourth component
>>1
    Is the control dependent variable a flow station output (Y/N) ?
>>N
    The dependent variable of control located at the Shaft
    designated by component number 10 is:
        1 - Net shaft power, h.P.
        2 - Actual shaft speed, R.P.M.
        3 - Actual speed of the first component, R.P.M.
        4 - Speed of the second component
        5 - Speed of the third component
        6 - Speed of the fourth component
        7 - Not used
        8 - Net shaft power / average shaft power
>>8
    Enter the desired value of the control dependent variable.
>>0
    Are the CDAT inputs correct up to this point (Y/N) ?
>>

Component number 19 is a Control

Is this control active (Y/N) ?
>>N
    Enter the desired tolerance (DEFAULT=.001).
>>
    Enter the minimum value of the independent variable (enter zero for
    no limit).
>>
    Enter the maximum value (zero for no limit).
>>
    Which CDAT variable is the independent variable for the Load
    designated by component number 12 for this control variable.
        1 - Load horsepower, h.P.
        2 - Switch
>>1
    Is the control dependent variable a flow station output (Y/N) ?
>>N
    The dependent variable of control located at the Shaft
    designated by component number 11 is:
        1 - Net shaft power, h.P.
        2 - Actual shaft speed, R.P.M.

```

```

3 - Actual speed of the first component, R.P.M.
4 - Speed of the second component
5 - Speed of the third component
6 - Speed of the fourth component
7 - Not used
8 - Net shaft power / average shaft power

>>8
Enter the desired value of the control dependent variable.

>>0
Are the CDAT inputs correct up to this point (Y/N) ?
>>

Select one: 0 - Off design mode.
             1 - Design mode calculation sequence.
IDESN=1
>>
Select one: 0 - Regular solution print out.
             1 - Extra print diagnostics + regular.
             2 - Full convergence history + regular.
IPRINT=1
>>0
Do you want a title card (Y/N) ?
>>Y
Enter title (one line max).
>>Regenerative Turboshaft Engine
Select one: 0 - No tabular data.
             1 - Tabular data.
             2 - Print tabular data.
>>1
Enter the scalar multiplier on table value of referred flow.
>>225
Enter the altitude (enter -1 to specify free stream static temperature
and pressure).
>>0
Enter the burner component number.
>>5
Enter the core nozzle component number.
>>9
Enter the fan nozzle component number (0=none).
>>0
Enter the number of active after burner components (MAX=5).
>>0
Do you want mach, thrust, and fuel flow in format compatible with
other performance codes (Y/N) ?
>>Y
Enter the design burner outlet temperature.
Default is the bot of the design point solution.
>>3200
Are all the table data decks on one tape (Y/N) ?
>>Y
Enter the file name.
>>DEFTAB
Enter the number of runs desired.
Note: full data sets are treated as one run and
      include any combination of constant dynamic
      pressure paths and constant altitude flight
      envelopes.

>>2

Changes to input data for case - 1

Do you want any changes in the input data (Y/N) ?
Note: controls associated with the design point should be deactivated here.
(default=NO)
>>N
Enter options (no spaces between entries)
A - Change altitude
M - Change Mach numbers
T - Change throttle setting points
B - Change burner or afterburner inputs
W - Change maximum weight flow
P - Change print controls
L - Change title

```

```

Q - Change tables
Z - Change all inputs
S - Stop
>>MTP
Select one: 0 - Regular solution print out.
             1 - Extra print diagnostics + regular.
             2 - Full convergence history + regular.
IPRINT=0
>>0
Enter the number of mach numbers to be run at the current altitude
(MAX=16).
>>1
On one line enter the Mach numbers.
>>0
Enter the number of throttle setting points to be run at the current
altitude (7=MAX).
>>1
Do you want mach, thrust, and fuel flow in format compatible with
other performance codes (Y/N) ?
>>Y
Do you want to generate a complete set of data (Y/N) ?
>>Y
Do you want cycle the input to improve QNEP reliability (y/n) ?
>>Y
Do you want to generate the data deck for constant
dynamic pressure paths (y/n) ?
>>N
Enter the starting altitude.
>>0
Enter the ending altitude.
>>40000
Enter the increment in altitude.
>>10000
Enter the minimum dynamic pressure (psf).
>>100
Enter the maximum dynamic pressure.
>>1500
At low altitudes and mach numbers the dynamic pressure may be less than
the minimum. For example if the dynamic pressure is less than the
minimum and the altitude is less than Mach*Slope+Intercept, data will
be computed for that point.
Enter the slope.
>>10000
Enter the intercept.
>>10000
Enter the number of throttle setting points to be run at point (MAX=7).
>>7
Enter the increments between throttle setting points (MAX=6).
>>6*100
Enter the increment between mach numbers.
>>.2
Enter the maximum allowable mach number (multiple of increment).
>>1.2
Enter the minimum allowable mach number (multiple of increment).
>>0
Is this data deck being run non-afterburning (Y/N) ?
>>Y
Enter the maximum turbine inlet temperature (R).
(or burner outlet temperature)
>>3200
Do you want to cycle the throttle setting points (y/n) ?
>>N
Another full data set (y/n) ?
>>N

The input file to QNEP has been written to CASE1.INP.
There are a total of 27 &D NAMELIST input cases
including design point cases.

```

## *QNEP Terminal Session*

The following is entered to run QNEP. The “-N=25” option limits the maximum number of iterations to 25 (default is 50) and the “-I” and “-O” options are used to override the default input and output files. See “Command Line Options” section for a complete list of available options.

```
QNEP -I CASE1.INP -O CASE1.DAT -N=25
```

The following message appears on the screen if the requested output file already exists:

```
QNEP; PC version: 1.40
```

```
Output file CASE1.INP already exists.  
Do you want to overwrite it (y/n) ?
```

Enter “n” here and the user is asked to enter the input file name. Enter “y” and the following appears on the screen:

```
QNEP; PC version: 1.40
```

```
Reading the first NAMELIST input...
```

When the first NAMELIST input and the table data have been read in by QNEP the following is written over the previous line:

```
Working the Design point case.....
```

If QNEP finds a solution to the design point case the following message appears. As QNEP proceeds through the input file the third line is continuously updated:

```
QNEP; PC version: 1.40
```

```
Design point complete.....
```

```
Working at NAMELIST: 5 - Altitude= 10000 Mach=0.40 TIT=3000
```

When all the NAMELIST input data have been read in and the output data generated, the following and final screen will appear:

```
QNEP; PC version: 1.40
```

```
Design point complete.....
```

```
Done...
```

```
Total number of good points = 169
```

```
Total Elapsed Time is 52 minutes 52 seconds
```

```
Number of points/min = 3.2
```

The QNEP output file begins below. The input file used to generate this output file is not shown. It does, however, appear as part of the output file, separated by the actual output data.

NAVAL AIR DEVELOPMENT CENTER

NEPII NAVY ENGINE PERFORMANCE COMPUTER CODE  
MODIFIED VERSION 1.00 - IBM PC OR COMPATIBLE

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
IPRINT=0,
NCOMP=19,
NOSTAT=12,
IDESN=1,
TABLES=1.,
FIGSET=1.,
JFIG(1, 1)= 1, 1, 0, 2, 0,
JFIG(1, 2)= 4, 2, 0, 3, 0,
JFIG(1, 3)= 2, 3, 0, 4,12,
JFIG(1, 4)= 6, 4, 8, 5, 9,
JFIG(1, 5)= 2, 5, 0, 6, 0,
JFIG(1, 6)= 5, 6, 0, 7, 0,
JFIG(1, 7)= 2, 7,12, 8, 0,
JFIG(1, 8)= 5, 9, 0,10, 0,
JFIG(1, 9)= 9,10, 0,11, 0,
JFIG(1,10)=11, 2, 6, 0, 0,
JFIG(1,11)=11, 8,12, 0, 0,
JFIG(1,12)=10, 0, 0, 0, 0,
JFIG(1,13)=12,10, 0, 8, 0,
JFIG(1,14)=12, 9, 0, 6, 0,
JFIG(1,15)=12, 4, 0, 4, 0,
JFIG(1,16)=12, 6, 0, 2, 0,
JFIG(1,17)=12, 2, 0, 1, 0,
JFIG(1,18)=12,10, 0,10, 0,
JFIG(1,19)=12,11, 0,12, 0,
CDAT( 1, 1)= 225.00000,      0.00000,      0.00000,      0.00000,      0.00000,
                  1.00000,    100.00000,      1.00000,      0.00000,      0.00000,
                  0.00000,      0.00000,      0.00000,      0.00000,      0.00000,
CDAT( 1, 2)=   2.00000,      0.00000,      1.00000,    701.00000,      1.00000,
                 702.00000,      1.00000,    703.00000,      1.00000,      0.00000,
                 0.00000,     0.87000,    12.00000,      1.00000,      0.00000,
CDAT( 1, 3)=   0.05000,      0.00000,      0.00000,      0.00000,      0.00000,
                 0.00000,      0.00000,      0.00000,     0.05000,      0.00000,
                 0.00000,      0.00000,      0.00000,      0.00000,      0.00000,
CDAT( 1, 4)=   0.05000,     0.05000,   1500.00000,      0.90000,      1.00000,
                 0.00000,      0.00000,      0.00000,      0.00000,      0.00000,
                 0.00000,      0.00000,      0.00000,      0.00000,      0.00000,
CDAT( 1, 5)=   0.05000,      0.00000,      0.00000,   3200.00000,     0.95000,
                 18500.00000,      0.00000,      0.00000,      0.00000,      0.00000,
                 0.00000,      0.00000,      0.00000,      0.00000,      0.00000,
CDAT( 1, 6)=   3.00000,      0.00000,      1.00000,   121.00000,      1.00000,
                 122.00000,      1.00000,      1.00000,      0.00000,    63.00000,
                 0.92000,    100.00000,      1.00000,      0.00000,      0.00000,
CDAT( 1, 7)=   0.02000,      0.00000,      0.00000,      0.00000,      0.00000,
                 0.00000,      0.00000,      1.00000,      0.00000,      0.00000,
                 0.00000,      0.00000,      0.00000,      0.00000,      0.00000,
CDAT( 1, 8)=   3.00000,      0.00000,      1.00000,   121.00000,      1.00000,
                 122.00000,      1.00000,      1.00000,      0.00000,    63.00000,
                 0.92000,    100.00000,      1.00000,      0.00000,      0.00000,
CDAT( 1, 9)= 300.00000,     0.98000,      0.00000,      0.00000,     0.98000,
                 0.00000,      0.00000,      0.00000,     1.00000,      0.00000,
                 0.00000,      0.00000,      0.00000,     0.00000,      0.00000,
CDAT( 1,10)= 1.00000,      1.00000,      1.00000,      1.00000,      1.00000,
                 0.00000,      0.00000,      0.00000,     0.00000,     0.00000,
                 0.00000,      0.00000,      0.00000,     0.00000,     0.00000,
CDAT( 1,11)= 1.00000,      1.00000,      1.00000,      1.00000,      1.00000,
                 0.00000,      0.00000,      0.00000,     0.00000,     0.00000,
                 0.00000,      0.00000,      0.00000,     0.00000,     0.00000,
CDAT( 1,12)= -250.00000,     0.00000,      0.00000,      0.00000,      0.00000,
```

```

          0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
          0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,13)= 0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
               8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
               0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,14)= 0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
               8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
               0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,15)= 0.00000,   0.00000,   0.00000,   3.00000,   0.00000,
               18.00000,   0.00000,   0.00000,   0.00000,   0.00000,
               0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,16)= 0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
               8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
               0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,17)= 0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
               8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
               0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,18)= 0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
               18.00000,   0.00000,   0.00000,   0.00000,   0.00000,
               0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,19)= 0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
               18.00000,   0.00000,   0.00000,   0.00000,   0.00000,
               0.00000,   0.00000,   0.00000,   0.00000,   0.00000,

```

WMAX= 225.000,

TIT= 3200.00,

JCB= 5,

JN1= 9,

JN2= 0,

TITLE=1., &END

#### Regenerative Turboshaft Engine

111 Maximum Referred Flow Schedule (max THET corresponds to Mach = 8)

Z	1	0.00000
ALT	1	0.0
THET	41	1.00000 1.00399 1.01587 1.03537 1.06207 1.09545 1.13490
THET	41	1.17983 1.22963 1.28374 1.34164 1.40285 1.46697 1.53362
THET	41	1.60250 1.67332 1.74585 1.81989 1.89526 1.97180 2.04939
THET	41	2.12791 2.20726 2.28736 2.36812 2.44949 2.53140 2.61381
THET	41	2.69666 2.77993 2.86356 2.94754 3.03183 3.11641 3.20125
THET	41	3.28633 3.37165 3.45717 3.54288 3.62877 3.71483
WMAX	41	1.00000 1.00000 1.00000 1.00000 1.00000 1.00000 0.97046
WMAX	41	0.89692 0.79985 0.69494 0.59259 0.49876 0.41613 0.34531
WMAX	41	0.28570 0.23615 0.19528 0.16172 0.13423 0.11172 0.09329
WMAX	41	0.07818 0.06575 0.05550 0.04703 0.04000 0.03415 0.02926
WMAX	41	0.02516 0.02172 0.01880 0.01634 0.01424 0.01245 0.01092
WMAX	41	0.00960 0.00847 0.00749 0.00664 0.00590 0.00526

EOT

11 INLET RECOVERY: AFFDL-TR-78-91 W.BALL VOL.IV INL \#15 - MACH 3.5 CONFIG

Z	1	0.00000
MACH	41	0.00000 0.200000 0.400000 0.600000 0.800000 1.000000 1.200000
MACH	41	1.400000 1.600000 1.800000 2.000000 2.200000 2.400000 2.600000
MACH	41	2.800000 3.000000 3.200001 3.400001 3.600001 3.800001 4.000000
MACH	41	4.200000 4.400000 4.600000 4.800000 5.000000 5.200000 5.400000
MACH	41	5.600000 5.800000 6.000000 6.200000 6.400000 6.600000 6.800000
MACH	41	7.000000 7.200000 7.400000 7.600000 7.800000 8.000000
WCOR	1	100.000000
PR	1	0.940576
PR	1	0.960310
PR	1	0.964039
PR	1	0.963528
PR	1	0.963237
PR	1	0.963359
PR	1	0.962240
PR	1	0.958171
PR	1	0.960342
PR	1	0.953321
PR	1	0.946685
PR	1	0.939465
PR	1	0.930920
PR	1	0.920539
PR	1	0.908042
PR	1	0.893375
PR	1	0.876715
PR	1	0.858471

PR	1	0.839235						
PR	1	0.819999						
PR	1	0.800763						
PR	1	0.781527						
PR	1	0.762291						
PR	1	0.743055						
PR	1	0.723819						
PR	1	0.704583						
PR	1	0.685347						
PR	1	0.666111						
PR	1	0.646875						
PR	1	0.627639						
PR	1	0.608403						
PR	1	0.589167						
PR	1	0.569931						
PR	1	0.550695						
PR	1	0.531459						
PR	1	0.512223						
PR	1	0.492987						
PR	1	0.473751						
PR	1	0.454515						
PR	1	0.435279						
PR	1	0.416043						
EOT								
701 P-COMPRESSOR FLOW VS. R, SPEED, AND ANGL								
ANGL	2	.000	90.000					
SPED	12	.100	.200	.300	.400	.500	.600	.700
SPED	12	.800	.900	1.000	1.100	1.200		
R	11	1.000	1.200	1.400	1.600	1.800	2.000	2.200
R	11	2.400	2.600	2.800	3.000			
FLOW	11	.6799	.9072	1.1263	1.3354	1.5329	1.7174	1.8878
FLOW	11	1.9300	1.9300	1.9300	1.9300			
FLOW	11	2.1767	2.4469	2.7084	2.9605	3.2023	3.4333	3.6528
FLOW	11	3.8605	3.8659	3.8659	3.8659			
FLOW	11	4.0067	4.2911	4.5638	4.8242	5.0718	5.3063	5.5274
FLOW	11	5.7347	5.9281	6.0359	6.0359			
FLOW	11	5.9447	6.2444	6.5281	6.7955	7.0462	7.2800	7.4968
FLOW	11	7.6965	7.8791	8.0448	8.1936			
FLOW	11	8.1875	8.5598	8.9043	9.2209	9.5092	9.7693	10.0014
FLOW	11	10.2058	10.3829	10.5333	10.6578			
FLOW	11	11.5667	11.9041	12.2114	12.4887	12.7363	12.9546	13.1440
FLOW	11	13.3053	13.4391	13.5463	13.6278			
FLOW	11	16.5719	16.8734	17.1413	17.3764	17.5791	17.7504	17.8911
FLOW	11	18.0020	18.0842	18.1387	18.1666			
FLOW	11	24.7218	25.0478	25.3314	25.5733	25.7748	25.9368	26.0607
FLOW	11	26.1478	26.1994	26.2169	26.2169			
FLOW	11	39.3618	39.8463	40.2614	40.6087	40.8900	41.1075	41.2634
FLOW	11	41.3599	41.3994	41.4007	41.4007			
FLOW	11	52.9939	53.1754	53.3365	53.4774	53.5984	53.7000	53.7825
FLOW	11	53.8462	53.8915	53.9189	53.9286			
FLOW	11	55.0028	55.0466	55.0874	55.1254	55.1604	55.1926	55.2220
FLOW	11	55.2485	55.2723	55.2932	55.3114			
FLOW	11	55.8892	55.8933	55.8972	55.9008	55.9042	55.9074	55.9103
FLOW	11	55.9130	55.9154	55.9175	55.9195			
SPED	12	.100	.200	.300	.400	.500	.600	.700
SPED	12	.800	.900	1.000	1.100	1.200		
R	11	1.000	1.200	1.400	1.600	1.800	2.000	2.200
R	11	2.400	2.600	2.800	3.000			
FLOW	11	1.9325	2.1478	2.3564	2.5577	2.7512	2.9366	3.1133
FLOW	11	3.2810	3.3009	3.3009	3.3009			
FLOW	11	5.1590	5.3683	5.5697	5.7629	5.9480	6.1246	6.2928
FLOW	11	6.4524	6.6033	6.7456	6.8792			
FLOW	11	8.5694	8.6525	8.7335	8.8122	8.8887	8.9630	9.0351
FLOW	11	9.1050	9.1726	9.2381	9.3014			
FLOW	11	12.0810	12.2443	12.3975	12.5409	12.6745	12.7984	12.9127
FLOW	11	13.0175	13.1129	13.1991	13.2761			
FLOW	11	16.1978	16.3644	16.5175	16.6572	16.7838	16.8974	16.9983
FLOW	11	17.0867	17.1628	17.2269	17.2793			
FLOW	11	21.2012	21.3348	21.4569	21.5677	21.6674	21.7562	21.8342
FLOW	11	21.9017	21.9587	22.0057	22.0427			
FLOW	11	27.3518	27.5095	27.6515	27.7782	27.8896	27.9862	28.0682
FLOW	11	28.1360	28.1897	28.2297	28.2565			
FLOW	11	35.4902	35.7164	35.9171	36.0928	36.2440	36.3712	36.4750

FLOW 11	36.5558	36.6143	36.6511	36.6667				
FLOW 11	45.4372	45.7540	46.0300	46.2663	46.4637	46.6231	46.7456	
FLOW 11	46.8321	46.8837	46.9016	46.9016				
FLOW 11	53.0199	53.1940	53.3488	53.4845	53.6015	53.7000	53.7805	
FLOW 11	53.8432	53.8885	53.9167	53.9283				
FLOW 11	55.0028	55.0466	55.0874	55.1254	55.1604	55.1926	55.2220	
FLOW 11	55.2485	55.2723	55.2932	55.3114				
FLOW 11	55.8892	55.8933	55.8972	55.9008	55.9042	55.9074	55.9103	
FLOW 11	55.9130	55.9154	55.9175	55.9195				
EOT								

P-COMPRESSOR EFF VS. R, SPEED, AND ANGL							
ANGL 2	.000	90.000					
SPED 12	.100	.200	.300	.400	.500	.600	.700
SPED 12	.800	.900	1.000	1.100	1.200		
R 11	1.000	1.200	1.400	1.600	1.800	2.000	2.200
R 11	2.400	2.600	2.800	3.000			
EFF 11	.7883	.8035	.8115	.8067	.7770	.6861	.3169
EFF 11	.0000	.0000	.0000	.0000			
EFF 11	.8108	.8114	.8053	.7887	.7544	.6861	.5246
EFF 11	.0258	.0000	.0000	.0000			
EFF 11	.8073	.8000	.7879	.7693	.7412	.6986	.6283
EFF 11	.5026	.2615	.0000	.0000			
EFF 11	.8015	.7929	.7809	.7645	.7422	.7119	.6679
EFF 11	.6010	.4978	.3322	.0448			
EFF 11	.8005	.7932	.7832	.7697	.7519	.7285	.6958
EFF 11	.6484	.5801	.4806	.3318			
EFF 11	.7998	.7938	.7862	.7766	.7647	.7498	.7306
EFF 11	.7047	.6707	.6263	.5685			
EFF 11	.8137	.8099	.8050	.7988	.7912	.7819	.7700
EFF 11	.7543	.7341	.7087	.6771			
EFF 11	.8509	.8499	.8481	.8453	.8415	.8365	.8296
EFF 11	.8197	.8066	.7898	.7690			
EFF 11	.8734	.8791	.8831	.8853	.8854	.8834	.8774
EFF 11	.8653	.8465	.8206	.7867			
EFF 11	.8699	.8713	.8720	.8721	.8714	.8700	.8672
EFF 11	.8625	.8558	.8468	.8357			
EFF 11	.8605	.8610	.8610	.8605	.8596	.8581	.8557
EFF 11	.8520	.8468	.8402	.8321			
EFF 11	.8438	.8436	.8431	.8423	.8411	.8396	.8374
EFF 11	.8344	.8305	.8256	.8198			
SPED 12	.100	.200	.300	.400	.500	.600	.700
SPED 12	.800	.900	1.000	1.100	1.200		
R 11	1.000	1.200	1.400	1.600	1.800	2.000	2.200
R 11	2.400	2.600	2.800	3.000			
EFF 11	.8115	.8106	.8032	.7857	.7515	.6861	.5396
EFF 11	.1283	.0000	.0000	.0000			
EFF 11	.7939	.7842	.7715	.7548	.7329	.7042	.6642
EFF 11	.6063	.5213	.3931	.1889			
EFF 11	.7590	.7530	.7465	.7394	.7317	.7233	.7140
EFF 11	.7035	.6916	.6783	.6635			
EFF 11	.7849	.7794	.7731	.7660	.7580	.7489	.7383
EFF 11	.7256	.7106	.6929	.6722			
EFF 11	.8025	.7986	.7941	.7889	.7831	.7764	.7686
EFF 11	.7591	.7478	.7345	.7191			
EFF 11	.8246	.8222	.8194	.8163	.8128	.8088	.8042
EFF 11	.7987	.7922	.7846	.7760			
EFF 11	.8562	.8551	.8537	.8518	.8495	.8467	.8433
EFF 11	.8387	.8330	.8260	.8178			
EFF 11	.8786	.8794	.8796	.8792	.8780	.8761	.8729
EFF 11	.8676	.8603	.8508	.8389			
EFF 11	.8780	.8812	.8834	.8843	.8841	.8825	.8785
EFF 11	.8710	.8597	.8443	.8247			
EFF 11	.8701	.8714	.8721	.8721	.8714	.8700	.8673
EFF 11	.8628	.8564	.8479	.8374			
EFF 11	.8605	.8610	.8610	.8605	.8596	.8581	.8557
EFF 11	.8520	.8468	.8402	.8321			
EFF 11	.8438	.8436	.8431	.8423	.8411	.8396	.8374
EFF 11	.8344	.8305	.8256	.8198			
EOT							

P-COMPRESSOR PR VS. R, SPEED, AND ANGL							
ANGL 2	.000	90.000					
SPED 12	.100	.200	.300	.400	.500	.600	.700
SPED 12	.800	.900	1.000	1.100	1.200		

R	11	1.000	1.200	1.400	1.600	1.800	2.000	2.200
R	11	2.400	2.600	2.800	3.000			
PR	11	1.0667	1.0583	1.0490	1.0390	1.0282	1.0168	1.0040
PR	11	1.0000	1.0000	1.0000	1.0000			
PR	11	1.2137	1.1864	1.1582	1.1290	1.0991	1.0683	1.0359
PR	11	1.0010	1.0000	1.0000	1.0000			
PR	11	1.3933	1.3492	1.3049	1.2603	1.2156	1.1708	1.1251
PR	11	1.0779	1.0293	1.0000	1.0000			
PR	11	1.6806	1.6120	1.5438	1.4763	1.4095	1.3435	1.2774
PR	11	1.2104	1.1429	1.0752	1.0075			
PR	11	2.2796	2.1572	2.0368	1.9187	1.8030	1.6900	1.5782
PR	11	1.4662	1.3549	1.2449	1.1368			
PR	11	3.1865	3.0126	2.8422	2.6754	2.5127	2.3541	2.1977
PR	11	2.0420	1.8879	1.7362	1.5876			
PR	11	4.5516	4.3191	4.0903	3.8657	3.6456	3.4304	3.2172
PR	11	3.0039	2.7915	2.5814	2.3746			
PR	11	6.8726	6.5686	6.2659	5.9651	5.6668	5.3717	5.0749
PR	11	4.7724	4.4660	4.1580	3.8503			
PR	11	11.6640	11.3122	10.9252	10.5060	10.0581	9.5850	9.0617
PR	11	8.4688	7.8186	7.1249	6.4023			
PR	11	16.3422	15.9880	15.6155	15.2258	14.8203	14.4000	13.9496
PR	11	13.4553	12.9210	12.3513	11.7505			
PR	11	17.0694	16.7059	16.3305	15.9440	15.5473	15.1412	14.7142
PR	11	14.2559	13.7690	13.2560	12.7201			
PR	11	17.3970	17.0481	16.6922	16.3299	15.9617	15.5882	15.2012
PR	11	14.7935	14.3666	13.9221	13.4617			
SPED	12	.100	.200	.300	.400	.500	.600	.700
SPED	12	.800	.900	1.000	1.100	1.200		
R	11	1.000	1.200	1.400	1.600	1.800	2.000	2.200
R	11	2.400	2.600	2.800	3.000			
PR	11	1.1476	1.1293	1.1103	1.0907	1.0705	1.0497	1.0277
PR	11	1.0039	1.0000	1.0000	1.0000			
PR	11	1.4337	1.3934	1.3533	1.3131	1.2732	1.2334	1.1932
PR	11	1.1523	1.1107	1.0685	1.0259			
PR	11	1.7043	1.6749	1.6457	1.6167	1.5879	1.5592	1.5307
PR	11	1.5020	1.4733	1.4445	1.4157			
PR	11	2.7789	2.6839	2.5901	2.4977	2.4066	2.3169	2.2279
PR	11	2.1391	2.0504	1.9623	1.8747			
PR	11	3.9030	3.7636	3.6260	3.4902	3.3563	3.2245	3.0935
PR	11	2.9624	2.8314	2.7009	2.5710			
PR	11	5.0763	4.9291	4.7831	4.6384	4.4951	4.3533	4.2118
PR	11	4.0694	3.9265	3.7832	3.6399			
PR	11	6.7709	6.5838	6.3968	6.2100	6.0237	5.8380	5.6505
PR	11	5.4592	5.2645	5.0670	4.8674			
PR	11	9.3585	9.1131	8.8613	8.6039	8.3414	8.0743	7.7959
PR	11	7.4998	7.1880	6.8626	6.5256			
PR	11	13.2976	12.9630	12.6028	12.2190	11.8134	11.3882	10.9238
PR	11	10.4034	9.8341	9.2236	8.5799			
PR	11	16.2950	15.9482	15.5842	15.2041	14.8090	14.4000	13.9625
PR	11	13.4834	12.9662	12.4151	11.8342			
PR	11	17.0694	16.7059	16.3305	15.9440	15.5473	15.1412	14.7142
PR	11	14.2559	13.7690	13.2560	12.7201			
PR	11	17.3970	17.0481	16.6922	16.3299	15.9617	15.5882	15.2012
PR	11	14.7935	14.3666	13.9221	13.4617			

EOT

## 121 TURBINE FLOW FUNCTION VS. PR, RPM, AND BETA

BETA	3	43.	53.	63.				
RPM	15	10.	20.	30.	40.	50.	60.	70.
RPM	15	80.	90.	100.	110.	120.	130.	140.
RPM	15	150.						
PR	20	1.10	1.20	1.40	1.60	1.80	2.00	2.20
PR	20	2.40	2.60	2.80	3.00	3.20	3.40	3.60
PR	20	3.80	4.00	4.20	4.40	4.60	4.80	
TFF	20	23.257	29.521	29.657	29.657	29.657	29.657	29.657
TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	16.862	26.094	29.657	29.657	29.657	29.657	29.657
TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	13.761	22.432	29.376	29.657	29.657	29.657	29.657
TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	12.313	19.809	27.816	29.655	29.657	29.657	29.657

TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	29.657	29.657	29.657	29.657	29.657	29.657	29.657
TFF	20	11.730	18.077	26.007	29.038	29.635	29.635	29.635
TFF	20	29.635	29.635	29.635	29.635	29.635	29.635	29.635
TFF	20	29.635	29.635	29.635	29.635	29.635	29.635	29.635
TFF	20	11.615	16.977	24.413	27.912	29.291	29.574	29.574
TFF	20	29.574	29.574	29.574	29.574	29.574	29.574	29.574
TFF	20	29.574	29.574	29.574	29.574	29.574	29.574	29.574
TFF	20	11.801	16.349	23.179	26.779	28.555	29.321	29.527
TFF	20	29.528	29.528	29.528	29.528	29.528	29.528	29.528
TFF	20	29.528	29.528	29.528	29.528	29.528	29.528	29.528
TFF	20	12.154	16.021	22.225	25.736	27.677	28.707	29.205
TFF	20	29.403	29.428	29.428	29.428	29.428	29.428	29.428
TFF	20	29.428	29.428	29.428	29.428	29.428	29.428	29.428
TFF	20	12.626	15.923	21.531	24.866	26.836	27.995	28.659
TFF	20	29.036	29.185	29.251	29.287	29.304	29.309	29.309
TFF	20	29.309	29.309	29.309	29.309	29.309	29.309	29.309
TFF	20	13.145	15.951	20.991	24.101	26.022	27.224	27.969
TFF	20	28.448	28.667	28.787	28.872	28.934	28.979	29.013
TFF	20	29.038	29.072	29.089	29.094	29.094	29.094	29.094
TFF	20	13.713	16.102	20.617	23.493	25.321	26.518	27.291
TFF	20	27.821	28.085	28.233	28.346	28.433	28.502	28.557
TFF	20	28.606	28.679	28.734	28.776	28.807	28.829	28.829
TFF	20	14.244	16.315	20.340	22.977	24.690	25.849	26.616
TFF	20	27.162	27.458	27.620	27.746	27.846	27.927	27.994
TFF	20	28.053	28.149	28.227	28.291	28.344	28.387	28.387
TFF	20	14.819	16.545	20.108	22.499	24.092	25.195	25.932
TFF	20	26.471	26.791	26.956	27.086	27.191	27.277	27.349
TFF	20	27.410	27.513	27.603	27.680	27.744	27.800	27.800
TFF	20	15.478	16.700	19.827	21.966	23.434	24.465	25.157
TFF	20	25.671	26.009	26.169	26.297	26.401	26.487	26.559
TFF	20	26.620	26.716	26.810	26.891	26.961	27.022	27.022
TFF	20	15.842	16.636	19.317	21.193	22.518	23.458	24.090
TFF	20	24.564	24.909	25.060	25.180	25.278	25.359	25.428
TFF	20	25.487	25.566	25.658	25.738	25.808	25.869	25.869
RPM	15	10.	20.	30.	40.	50.	60.	70.
RPM	15	80.	90.	100.	110.	120.	130.	140.
RPM	15	150.						
PR	20	1.10	1.20	1.40	1.60	1.80	2.00	2.20
PR	20	2.40	2.60	2.80	3.00	3.20	3.40	3.60
PR	20	3.80	4.00	4.20	4.40	4.60	4.80	4.80
TFF	20	24.262	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	18.635	26.958	28.328	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	15.355	24.324	28.328	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	13.590	21.975	27.957	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	28.328	28.328	28.328	28.328	28.328	28.328	28.328
TFF	20	12.708	20.126	26.839	28.307	28.307	28.307	28.307
TFF	20	28.307	28.307	28.307	28.307	28.307	28.307	28.307
TFF	20	28.307	28.307	28.307	28.307	28.307	28.307	28.307
TFF	20	12.337	18.821	25.557	27.913	28.248	28.248	28.248
TFF	20	28.248	28.248	28.248	28.248	28.248	28.248	28.248
TFF	20	28.248	28.248	28.248	28.248	28.248	28.248	28.248
TFF	20	12.305	17.919	24.414	27.199	28.115	28.205	28.205
TFF	20	28.205	28.205	28.205	28.205	28.205	28.205	28.205
TFF	20	28.205	28.205	28.205	28.205	28.205	28.205	28.205
TFF	20	12.471	17.305	23.423	26.365	27.634	28.067	28.109
TFF	20	28.109	28.109	28.109	28.109	28.109	28.109	28.109
TFF	20	28.109	28.109	28.109	28.109	28.109	28.109	28.109
TFF	20	12.781	16.930	22.625	25.569	27.018	27.692	27.957
TFF	20	27.995	27.995	27.995	27.995	27.995	27.995	27.995
TFF	20	27.995	27.995	27.995	27.995	27.995	27.995	27.995
TFF	20	13.154	16.712	21.946	24.795	26.314	27.120	27.543
TFF	20	27.735	27.789	27.790	27.790	27.790	27.790	27.790
TFF	20	27.790	27.790	27.790	27.790	27.790	27.790	27.790
TFF	20	13.593	16.630	21.421	24.126	25.648	26.516	27.030
TFF	20	27.322	27.471	27.543	27.567	27.567	27.567	27.567

TFF	20	27.567	27.567	27.567	27.567	27.567	27.567
TFF	20	14.054	16.633	20.987	23.520	25.002	25.885
TFF	20	26.792	26.999	27.127	27.205	27.250	27.273
TFF	20	27.283	27.283	27.283	27.283	27.283	27.283
TFF	20	14.497	16.679	20.601	22.946	24.359	25.223
TFF	20	26.170	26.407	26.569	26.679	26.755	26.808
TFF	20	26.858	26.871	26.881	26.888	26.893	26.898
TFF	20	14.825	16.685	20.172	22.313	23.636	24.459
TFF	20	25.398	25.647	25.823	25.951	26.044	26.112
TFF	20	26.187	26.208	26.225	26.240	26.252	26.262
TFF	20	15.052	16.482	19.520	21.435	22.642	23.402
TFF	20	24.293	24.539	24.716	24.848	24.947	25.022
TFF	20	25.108	25.133	25.154	25.172	25.186	25.199
RPM	15	10.	20.	30.	40.	50.	60.
RPM	15	80.	90.	100.	110.	120.	130.
RPM	15	150.					
PR	20	1.10	1.20	1.40	1.60	1.80	2.00
PR	20	2.40	2.60	2.80	3.00	3.20	3.40
PR	20	3.80	4.00	4.20	4.40	4.60	4.80
TFF	20	18.263	24.140	25.834	25.834	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	14.388	21.531	25.769	25.834	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	12.089	19.311	24.916	25.834	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	10.802	17.556	23.646	25.593	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	25.834	25.834	25.834	25.834	25.834	25.834
TFF	20	10.085	16.170	22.329	24.860	25.718	25.815
TFF	20	25.815	25.815	25.815	25.815	25.815	25.815
TFF	20	25.815	25.815	25.815	25.815	25.815	25.815
TFF	20	9.754	15.134	21.111	23.927	25.192	25.668
TFF	20	25.762	25.762	25.762	25.762	25.762	25.762
TFF	20	25.762	25.762	25.762	25.762	25.762	25.762
TFF	20	9.684	14.418	20.088	23.005	24.495	25.236
TFF	20	25.710	25.722	25.722	25.722	25.722	25.722
TFF	20	25.722	25.722	25.722	25.722	25.722	25.722
TFF	20	9.774	13.879	19.217	22.118	23.713	24.611
TFF	20	25.405	25.555	25.621	25.635	25.635	25.635
TFF	20	25.635	25.635	25.635	25.635	25.635	25.635
TFF	20	9.985	13.520	18.509	21.328	22.955	23.935
TFF	20	24.922	25.168	25.325	25.424	25.483	25.515
TFF	20	25.531	25.531	25.531	25.531	25.531	25.531
TFF	20	10.255	13.288	17.902	20.592	22.199	23.208
TFF	20	24.297	24.601	24.815	24.967	25.077	25.156
TFF	20	25.255	25.278	25.294	25.307	25.317	25.324
TFF	20	10.598	13.172	17.425	19.964	21.522	22.526
TFF	20	23.659	23.993	24.239	24.423	24.563	24.670
TFF	20	24.810	24.848	24.880	24.906	24.928	24.947
TFF	20	10.948	13.135	17.024	19.401	20.891	21.867
TFF	20	23.001	23.348	23.608	23.808	23.963	24.086
TFF	20	24.242	24.288	24.327	24.360	24.389	24.414
TFF	20	11.273	13.134	16.669	18.874	20.283	21.214
TFF	20	22.320	22.665	22.928	23.132	23.293	23.421
TFF	20	23.581	23.630	23.672	23.708	23.739	23.766
TFF	20	11.642	13.139	16.287	18.311	19.625	20.498
TFF	20	21.552	21.885	22.141	22.341	22.500	22.627
TFF	20	22.783	22.832	22.873	22.909	22.940	22.967
TFF	20	11.948	12.983	15.734	17.555	18.757	19.557
TFF	20	20.535	20.846	21.086	21.274	21.424	21.544
TFF	20	21.692	21.738	21.776	21.810	21.838	21.863
EOT							

#### 122 TURBINE EFFICIENCY VS. PR, RPM, AND BETA

BETA	3	43.	53.	63.			
RPM	15	10.	20.	30.	40.	50.	60.
RPM	15	80.	90.	100.	110.	120.	130.
RPM	15	150.					
PR	20	1.10	1.20	1.40	1.60	1.80	2.00
PR	20	2.40	2.60	2.80	3.00	3.20	3.40
PR	20	3.80	4.00	4.20	4.40	4.60	4.80

EFF	20	.441	.395	.342	.312	.290	.275	.263
EFF	20	.253	.246	.240	.234	.230	.226	.222
EFF	20	.219	.217	.214	.212	.210	.208	
EFF	20	.535	.548	.530	.497	.474	.457	.442
EFF	20	.431	.421	.413	.406	.400	.395	.390
EFF	20	.386	.381	.377	.373	.370	.367	
EFF	20	.549	.609	.623	.606	.589	.573	.561
EFF	20	.552	.540	.531	.522	.515	.508	.502
EFF	20	.497	.492	.489	.487	.481	.476	
EFF	20	.534	.627	.670	.668	.657	.648	.637
EFF	20	.626	.616	.608	.600	.596	.584	.573
EFF	20	.564	.555	.547	.539	.533	.527	
EFF	20	.505	.622	.691	.701	.698	.693	.684
EFF	20	.675	.668	.663	.646	.631	.617	.606
EFF	20	.595	.585	.577	.569	.561	.555	
EFF	20	.465	.603	.697	.718	.721	.720	.714
EFF	20	.708	.703	.685	.667	.651	.637	.624
EFF	20	.613	.603	.594	.588	.586	.584	
EFF	20	.417	.574	.692	.723	.733	.735	.732
EFF	20	.729	.719	.698	.679	.663	.648	.636
EFF	20	.624	.614	.610	.608	.607	.605	
EFF	20	.361	.538	.680	.721	.736	.742	.742
EFF	20	.741	.727	.705	.686	.670	.655	.642
EFF	20	.631	.624	.623	.622	.621	.619	
EFF	20	.300	.497	.662	.713	.734	.743	.746
EFF	20	.747	.731	.709	.690	.674	.659	.646
EFF	20	.635	.632	.631	.630	.630	.629	
EFF	20	.233	.451	.640	.700	.727	.740	.745
EFF	20	.748	.732	.711	.692	.676	.661	.648
EFF	20	.637	.636	.636	.635	.635	.634	
EFF	20	.162	.401	.614	.684	.716	.733	.741
EFF	20	.746	.731	.710	.692	.676	.662	.649
EFF	20	.638	.638	.638	.638	.638	.637	
EFF	20	.076	.349	.584	.665	.702	.724	.733
EFF	20	.741	.729	.709	.691	.675	.661	.648
EFF	20	.637	.638	.638	.638	.638	.638	
EFF	20	.005	.294	.550	.641	.685	.711	.724
EFF	20	.732	.726	.706	.689	.673	.659	.647
EFF	20	.636	.636	.636	.637	.637	.637	
EFF	20	.000	.235	.514	.614	.665	.697	.712
EFF	20	.722	.722	.702	.685	.670	.657	.645
EFF	20	.634	.632	.633	.634	.634	.635	
EFF	20	.000	.177	.474	.584	.644	.680	.698
EFF	20	.710	.716	.698	.681	.667	.654	.642
EFF	20	.631	.627	.628	.629	.630	.631	
RPM	15	10.	20.	30.	40.	50.	60.	70.
RPM	15	80.	90.	100.	110.	120.	130.	140.
RPM	15	150.						
PR	20	1.10	1.20	1.40	1.60	1.80	2.00	2.20
PR	20	2.40	2.60	2.80	3.00	3.20	3.40	3.60
PR	20	3.80	4.00	4.20	4.40	4.60	4.80	
EFF	20	.511	.445	.376	.338	.312	.294	.280
EFF	20	.270	.261	.254	.248	.243	.239	.235
EFF	20	.231	.228	.225	.223	.221	.218	
EFF	20	.658	.659	.604	.558	.527	.503	.485
EFF	20	.470	.458	.448	.440	.432	.425	.419
EFF	20	.414	.409	.405	.401	.398	.394	
EFF	20	.698	.768	.736	.702	.673	.651	.632
EFF	20	.616	.603	.592	.583	.575	.567	.561
EFF	20	.556	.551	.546	.542	.538	.535	
EFF	20	.693	.817	.813	.792	.771	.751	.734
EFF	20	.720	.708	.698	.690	.683	.676	.670
EFF	20	.663	.658	.652	.647	.643	.639	
EFF	20	.668	.828	.856	.848	.835	.818	.804
EFF	20	.793	.784	.776	.769	.760	.753	.746
EFF	20	.740	.735	.730	.725	.721	.717	
EFF	20	.629	.820	.877	.882	.875	.863	.853
EFF	20	.845	.839	.831	.823	.816	.809	.803
EFF	20	.798	.793	.789	.785	.781	.777	
EFF	20	.579	.795	.883	.900	.899	.892	.886
EFF	20	.881	.876	.868	.862	.856	.850	.845
EFF	20	.841	.837	.833	.826	.818	.810	
EFF	20	.520	.758	.878	.907	.912	.910	.908

EFF	20	.906	.900	.895	.889	.885	.880	.876
EFF	20	.873	.867	.858	.849	.841	.833	
EFF	20	.455	.712	.864	.906	.918	.919	.920
EFF	20	.921	.917	.913	.909	.905	.902	.898
EFF	20	.894	.884	.874	.865	.857	.849	
EFF	20	.383	.660	.845	.898	.917	.922	.927
EFF	20	.929	.927	.924	.921	.919	.916	.914
EFF	20	.905	.895	.885	.876	.868	.860	
EFF	20	.306	.602	.819	.885	.910	.920	.928
EFF	20	.932	.932	.930	.929	.927	.926	.924
EFF	20	.912	.902	.892	.883	.875	.868	
EFF	20	.226	.540	.790	.868	.900	.914	.925
EFF	20	.932	.933	.933	.932	.932	.931	.928
EFF	20	.916	.906	.897	.888	.880	.872	
EFF	20	.142	.476	.756	.846	.887	.905	.918
EFF	20	.928	.930	.931	.932	.933	.933	.929
EFF	20	.918	.908	.899	.890	.882	.875	
EFF	20	.045	.411	.718	.822	.870	.892	.908
EFF	20	.921	.925	.927	.929	.931	.931	.929
EFF	20	.918	.908	.899	.891	.883	.876	
EFF	20	.000	.343	.677	.794	.850	.877	.896
EFF	20	.911	.917	.921	.924	.926	.928	.927
EFF	20	.917	.907	.898	.890	.882	.875	
RPM	15	10.	20.	30.	40.	50.	60.	70.
RPM	15	80.	90.	100.	110.	120.	130.	140.
RPM	15	150.						
PR	20	1.10	1.20	1.40	1.60	1.80	2.00	2.20
PR	20	2.40	2.60	2.80	3.00	3.20	3.40	3.60
PR	20	3.80	4.00	4.20	4.40	4.60	4.80	
EFF	20	.453	.378	.309	.275	.254	.238	.227
EFF	20	.218	.211	.205	.200	.195	.192	.188
EFF	20	.185	.183	.181	.178	.177	.175	
EFF	20	.630	.596	.529	.480	.449	.426	.409
EFF	20	.395	.384	.374	.366	.359	.353	.348
EFF	20	.343	.339	.335	.332	.329	.326	
EFF	20	.693	.728	.674	.630	.597	.572	.553
EFF	20	.537	.524	.512	.503	.494	.487	.480
EFF	20	.474	.469	.464	.460	.456	.452	
EFF	20	.703	.801	.771	.737	.707	.684	.664
EFF	20	.647	.633	.622	.612	.603	.595	.587
EFF	20	.581	.575	.570	.565	.561	.556	
EFF	20	.680	.830	.833	.810	.788	.766	.747
EFF	20	.732	.719	.707	.697	.688	.680	.673
EFF	20	.666	.660	.655	.650	.646	.641	
EFF	20	.637	.831	.869	.860	.844	.825	.810
EFF	20	.796	.783	.773	.763	.755	.747	.740
EFF	20	.734	.729	.724	.719	.714	.710	
EFF	20	.580	.812	.886	.891	.881	.868	.855
EFF	20	.843	.832	.823	.814	.807	.800	.794
EFF	20	.788	.783	.778	.774	.770	.766	
EFF	20	.513	.774	.888	.908	.905	.897	.887
EFF	20	.877	.868	.860	.853	.846	.841	.835
EFF	20	.830	.826	.821	.817	.809	.802	
EFF	20	.436	.722	.878	.913	.918	.915	.909
EFF	20	.901	.894	.888	.882	.876	.871	.867
EFF	20	.863	.859	.850	.841	.833	.826	
EFF	20	.353	.663	.859	.910	.923	.925	.921
EFF	20	.917	.912	.907	.902	.898	.894	.891
EFF	20	.887	.878	.868	.859	.851	.843	
EFF	20	.268	.595	.833	.898	.920	.928	.928
EFF	20	.925	.923	.919	.916	.913	.910	.908
EFF	20	.901	.890	.880	.871	.863	.856	
EFF	20	.173	.523	.799	.881	.912	.924	.928
EFF	20	.928	.928	.926	.925	.923	.921	.919
EFF	20	.909	.898	.889	.880	.872	.864	
EFF	20	.066	.445	.761	.858	.899	.916	.924
EFF	20	.927	.928	.928	.928	.928	.927	.925
EFF	20	.914	.903	.894	.885	.877	.869	
EFF	20	.000	.372	.717	.830	.881	.903	.915
EFF	20	.921	.924	.926	.928	.928	.928	.927
EFF	20	.916	.906	.896	.888	.880	.872	
EFF	20	.000	.295	.669	.799	.859	.887	.903
EFF	20	.912	.917	.921	.924	.925	.927	.926

EFF 20 .915 .906 .897 .888 .880 .873  
 EOT  
 1 Regenerative Turboshaft Engine

CONFIGURATION DATA 12 STATIONS 19 COMPONENTS

COMPONENT NUMBER	NKIND TYPE	UPSTREAM STATIONS		DOWNSTREAM STATIONS	
		1	0	2	0
1	1	INLET	1	0	2
2	4	COMPRESR	2	0	3
3	2	DUCT B	3	0	4
4	6	HEAT EXC	4	8	5
5	2	DUCT B	5	0	6
6	5	TURBINE	6	0	7
7	2	DUCT B	7	12	8
8	5	TURBINE	9	0	10
9	9	NOZZLE	10	0	11
10	11	SHAFT	2	6	0
11	11	SHAFT	8	12	0
12	10	LOAD	0	0	0
13	12	CONTROL	10	0	8
14	12	CONTROL	9	0	6
15	12	CONTROL	4	0	4
16	12	CONTROL	6	0	2
17	12	CONTROL	2	0	1
18	12	CONTROL	10	0	10
19	12	CONTROL	11	0	12

CONTROL INFORMATION

13 VARY CDAT 1 OF COMPONENT 8 SO THAT STATP 8 OF FLOW STATION 10 EQUALS 0.00000E+00  
 14 VARY CDAT 1 OF COMPONENT 6 SO THAT STATP 8 OF FLOW STATION 9 EQUALS 0.00000E+00  
 15 VARY CDAT 3 OF COMPONENT 4 SO THAT DATOUT 8 OF COMPONENT 4 EQUALS 0.00000E+00  
 16 VARY CDAT 1 OF COMPONENT 2 SO THAT STATP 8 OF FLOW STATION 6 EQUALS 0.00000E+00  
 17 VARY CDAT 1 OF COMPONENT 1 SO THAT STATP 8 OF FLOW STATION 2 EQUALS 0.00000E+00  
 18 VARY CDAT 1 OF COMPONENT 10 SO THAT DATOUT 8 OF COMPONENT 10 EQUALS 0.00000E+00  
 19 VARY CDAT 1 OF COMPONENT 12 SO THAT DATOUT 8 OF COMPONENT 11 EQUALS 0.00000E+00

1 Regenerative Turboshaft Engine

DESIGN POINT MODE

CDAT( 1,1-8 )	0.22500E+03	0.00000E+00	0.14696E+02	0.00000E+00	0.00000E+00	0.10000E+01	0.10000E+03	0.10000E+01
CDAT( 1,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 2,1-8 )	0.20000E+01	0.00000E+00	0.10000E+01	0.70100E+03	0.41899E+01	0.70200E+03	0.10000E-01	0.70300E+03
CDAT( 2,9-15)	0.82090E+00	0.00000E+00	0.00000E+00	0.87000E+00	0.12000E+02	0.10000E+01	0.00000E+00	0.00000E+00
CDAT( 3,1-8 )	0.00000E+00	0.00000E+00	0.27381E-04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 3,9-15)	0.50000E-01	0.00000E+00						
CDAT( 4,1-8 )	0.50000E-01	0.50000E-01	0.15000E+04	0.90000E+00	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 4,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 5,1-8 )	0.00000E+00	0.00000E+00	0.10573E-04	0.32000E+04	0.95000E+00	0.18500E+05	0.00000E+00	0.00000E+00
CDAT( 5,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 6,1-8 )	0.30000E+01	0.00000E+00	0.40260E-02	0.12100E+03	0.20892E+01	0.12200E+03	0.10200E+01	0.65446E+00
CDAT( 6,9-15)	0.00000E+00	0.63000E+02	0.92000E+00	0.10000E+03	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 7,1-8 )	0.00000E+00	0.00000E+00	0.68426E-06	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.10000E+01
CDAT( 7,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 8,1-8 )	0.30000E+01	0.00000E+00	0.58252E-02	0.12100E+03	0.37674E+01	0.12200E+03	0.10200E+01	0.40561E-02
CDAT( 8,9-15)	0.00000E+00	0.63000E+02	0.92000E+00	0.10000E+03	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 9,1-8 )	0.28525E+03	0.98000E+00	0.00000E+00	0.00000E+00	0.98000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 9,9-15)	0.10000E+01	0.00000E+00						
CDAT(10,1-8 )	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT(10,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT(11,1-8 )	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT(11,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT(12,1-8 )	-0.25000E+03	0.00000E+00						
CDAT(12,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT(13,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00

CDAT(13,9-15)	0.00000E+00							
CDAT(14,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(14,9-15)	0.00000E+00							
CDAT(15,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.30000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(15,9-15)	0.00000E+00							
CDAT(16,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(16,9-15)	0.00000E+00							
CDAT(17,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(17,9-15)	0.00000E+00							
CDAT(18,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(18,9-15)	0.00000E+00							
CDAT(19,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(19,9-15)	0.00000E+00							

1 Regenerative Turboshaft Engine

#### STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW	TOTAL PRESSURE	TOTAL TEMPERATURE	FUEL/AIR RATIO	REFERRED FLOW	MACH NUMBER	STATIC INTERFACE RELATIVE	
							STATP4	STATP7
							STATP2	STATP8
1	0.22500E+03	0.14696E+02	0.51867E+03	0.00000E+00	0.22500E+03	0.00000E+00	0.00000E+00	0.00000E+00
2	0.22500E+03	0.14696E+02	0.51867E+03	0.00000E+00	0.22500E+03	0.00000E+00	0.00000E+00	0.00000E+00
3	0.22500E+03	0.17635E+03	0.11218E+04	0.00000E+00	0.27575E+02	0.00000E+00	0.00000E+00	0.00000E+00
4	0.21375E+03	0.16753E+03	0.11218E+04	0.00000E+00	0.27575E+02	0.00000E+00	0.00000E+00	0.00000E+00
5	0.21375E+03	0.15916E+03	0.26218E+04	0.00000E+00	0.44374E+02	0.00000E+00	0.00000E+00	0.00000E+00
6	0.21606E+03	0.15120E+03	0.32000E+04	0.10807E-01	0.52162E+02	0.00000E+00	0.00000E+00	0.00000E+00
7	0.21606E+03	0.65485E+02	0.26850E+04	0.10807E-01	0.11032E+03	0.00000E+00	0.00000E+00	0.00000E+00
8	0.22731E+03	0.64176E+02	0.26131E+04	0.10267E-01	0.11684E+03	0.00000E+00	0.00000E+00	0.00000E+00
9	0.22731E+03	0.60967E+02	0.15285E+04	0.10267E-01	0.94062E+02	0.00000E+00	0.00000E+00	0.00000E+00
10	0.22731E+03	0.60476E+02	0.15256E+04	0.10267E-01	0.94735E+02	0.10000E+01	0.32414E+02	0.00000E+00
11	0.22731E+03	0.60476E+02	0.15256E+04	0.10267E-01	0.94735E+02	0.98000E+00	0.14696E+02	0.00000E+00
12	0.11250E+02	0.00000E+00	0.11218E+04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

#### COMPONENT OUTPUT DATA

COMPONENT	NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1 INLET	1	0.00000E+00	0.00000E+00	0.00000E+00	0.10000E+01	0.10000E+01	0.00000E+00	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00
2 COMPRESR	2	-0.46972E+05	0.10000E+01	0.00000E+00	0.20000E+01	0.10000E+01	0.10000E+01	0.41899E+01	0.87000E+00	0.12000E+02	
3 DUCT B	3	0.00000E+00	0.50000E-01	0.00000E+00							
4 HEAT EXC	4	0.50000E-01	0.50000E-01	0.00000E+00	0.90000E+00	0.10000E+01	0.13422E+04	0.90000E+00	0.11759E+00	0.00000E+00	0.00000E+00
5 DUCT B	5	0.00000E+00	0.50000E-01	0.00000E+00	0.10807E-01	0.00000E+00	0.83164E+04	0.00000E+00	0.18500E+05	0.95000E+00	
6 TURBINE	6	0.46972E+05	0.10000E+01	0.63000E+02	0.30000E+01	0.32000E+04	0.10000E+03	0.20892E+01	0.92000E+00	0.23089E+01	
7 DUCT B	7	0.00000E+00	0.20000E-01	0.00000E+00							
8 TURBINE	8	0.25000E+03	0.10000E+01	0.63000E+02	0.30000E+01	0.15285E+04	0.10000E+03	0.37674E+01	0.92000E+00	0.10081E+01	
9 NOZZLE	9	0.17084E+05	0.17028E+04	0.18657E+01	0.17375E+04	0.28525E+03	0.98000E+00	0.98000E+00	0.00000E+00	0.41152E+01	
10 SHAFT	10	0.00000E+00	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
11 SHAFT	11	0.00000E+00	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
12 LOAD	12	-0.25000E+03	0.10000E+01	0.00000E+00							

#### PERFORMANCE OUTPUTS

(1) NET JET THRUST (LBS)	17084.13	(2) NET BRAKE SHP	0.00	(3) AIRFLOW (LB/SEC)	225.00
(4) TSFC (LB/HR/LB)	0.4868	(5) BSFC (LB/HR/HP)	0.0000	(6) FUEL FLOW (LB/HR)	8316.36
(7) NET THRUST/AIRFLOW	75.93	(8) NET BSHP/AIRFLOW	0.00	(9) INLET DRAG (LBS)	0.00

0 ITERATIONS 2 PASSES

1 Regenerative Turboshaft Engine

#### NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
IPRINT=0,
IDESN=0,
FIGSET=0.,
WMAX= 225.000,
TIT= 3200.00,
JCB= 5,
JN1= 9,
JN2= 0,
```

PUNCH0=1.,  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.000,  
 NP=1,  
 TDEL(1)= 0.000,  
 TITLE=1., &END  
 Regenerative Turbohaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.000	17223.		0. 10496.	0.609	225.1	0.000	3200.	0.	0.000	0.	1535.	4.14	285.	1.000	3	1707.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.000,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turbohaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.000	17223.		0. 10496.	0.609	225.1	0.000	3200.	0.	0.000	0.	1535.	4.14	285.	1.000	0	1707.
0.	0.000	16050.		0. 9630.	0.600	215.8	0.000	3100.	0.	0.000	0.	1494.	3.91	285.	1.000	12	1685.
0.	0.000	14952.		0. 8848.	0.592	207.3	0.000	3000.	0.	0.000	0.	1453.	3.70	285.	1.000	5	1663.
0.	0.000	13905.		0. 8118.	0.584	198.9	0.000	2900.	0.	0.000	0.	1412.	3.50	285.	1.000	3	1640.
0.	0.000	12880.		0. 7426.	0.577	190.6	0.000	2800.	0.	0.000	0.	1371.	3.30	285.	1.000	3	1617.
0.	0.000	11869.		0. 6766.	0.570	182.2	0.000	2700.	0.	0.000	0.	1331.	3.10	285.	1.000	2	1593.
0.	0.000	10868.		0. 6132.	0.564	173.7	0.000	2600.	0.	0.000	0.	1290.	2.91	285.	1.000	2	1568.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.200,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turbohaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.200	15918.		0. 10605.	0.666	222.5	0.000	3200.	0.	0.000	0.	1537.	4.20	285.	1.000	5	1708.
0.	0.200	14823.		0. 9752.	0.658	213.7	0.000	3100.	0.	0.000	0.	1496.	3.97	285.	1.000	4	1686.
0.	0.200	13779.		0. 8964.	0.651	205.3	0.000	3000.	0.	0.000	0.	1455.	3.76	285.	1.000	3	1664.
0.	0.200	12783.		0. 8227.	0.644	197.0	0.000	2900.	0.	0.000	0.	1414.	3.55	285.	1.000	3	1641.
0.	0.200	11802.		0. 7526.	0.638	188.8	0.000	2800.	0.	0.000	0.	1374.	3.35	285.	1.000	3	1618.
0.	0.200	10835.		0. 6856.	0.633	180.5	0.000	2700.	0.	0.000	0.	1333.	3.15	285.	1.000	4	1594.
0.	0.200	9876.		0. 6213.	0.629	172.0	0.000	2600.	0.	0.000	0.	1292.	2.96	285.	1.000	3	1570.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.400,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turbohaft Engine

1 Regenerative Turbohaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.400	15169.		0. 11007.	0.726	216.0	0.000	3200.	0.	0.000	0.	1543.	4.38	285.	1.000	2	1712.
0.	0.400	14118.		0. 10144.	0.718	207.7	0.000	3100.	0.	0.000	0.	1503.	4.15	285.	1.000	4	1690.
0.	0.400	13096.		0. 9328.	0.712	199.6	0.000	3000.	0.	0.000	0.	1462.	3.93	285.	1.000	3	1668.
0.	0.400	12110.		0. 8562.	0.707	191.5	0.000	2900.	0.	0.000	0.	1421.	3.72	285.	1.000	2	1645.
0.	0.400	11141.		0. 7829.	0.703	183.5	0.000	2800.	0.	0.000	0.	1381.	3.50	285.	1.000	2	1622.
0.	0.400	10191.		0. 7127.	0.699	175.3	0.000	2700.	0.	0.000	0.	1341.	3.30	285.	1.000	3	1599.
0.	0.400	9235.		0. 6449.	0.698	166.9	0.000	2600.	0.	0.000	0.	1300.	3.09	285.	1.000	5	1574.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 0.00,  
NM= 1,  
XMA(1)= 0.600,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.600	14858.	0.	11725.	0.789	206.3	0.000	3200.	0.	0.000	0.	1554.	4.71	285.	1.000	2	1718.	
0.	0.600	13818.	0.	10818.	0.783	198.5	0.000	3100.	0.	0.000	0.	1514.	4.47	285.	1.000	2	1696.	
0.	0.600	12789.	0.	9947.	0.778	190.7	0.000	3000.	0.	0.000	0.	1474.	4.23	285.	1.000	3	1674.	
0.	0.600	11792.	0.	9124.	0.774	183.0	0.000	2900.	0.	0.000	0.	1434.	4.00	285.	1.000	3	1652.	
0.	0.600	10811.	0.	8335.	0.771	175.2	0.000	2800.	0.	0.000	0.	1393.	3.77	285.	1.000	2	1629.	
0.	0.600	9836.	0.	7576.	0.770	167.2	0.000	2700.	0.	0.000	0.	1353.	3.54	285.	1.000	3	1606.	
0.	0.600	8843.	0.	6834.	0.773	158.6	0.000	2600.	0.	0.000	0.	1313.	3.31	285.	1.000	4	1582.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 0.00,  
NM= 1,  
XMA(1)= 0.800,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.800	14909.	0.	12780.	0.857	194.2	0.000	3200.	0.	0.000	0.	1570.	5.20	285.	1.000	3	1726.	
0.	0.800	13830.	0.	11785.	0.852	186.8	0.000	3100.	0.	0.000	0.	1530.	4.93	285.	1.000	3	1705.	
0.	0.800	12774.	0.	10834.	0.848	179.5	0.000	3000.	0.	0.000	0.	1490.	4.66	285.	1.000	3	1683.	
0.	0.800	11737.	0.	9924.	0.846	172.0	0.000	2900.	0.	0.000	0.	1450.	4.40	285.	1.000	3	1661.	
0.	0.800	10696.	0.	9040.	0.845	164.3	0.000	2800.	0.	0.000	0.	1410.	4.14	285.	1.000	2	1639.	
0.	0.800	9653.	0.	8185.	0.848	156.2	0.000	2700.	0.	0.000	0.	1370.	3.88	285.	1.000	2	1616.	
0.	0.800	8629.	0.	7369.	0.854	148.0	0.000	2600.	0.	0.000	0.	1330.	3.62	285.	1.000	4	1592.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
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NM= 1,  
XMA(1)= 1.000,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine

1 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	1.000	15218.	0.	14189.	0.932	180.5	0.000	3200.	0.	0.000	0.	1591.	5.85	285.	1.000	3	1737.	
0.	1.000	14073.	0.	13067.	0.928	173.5	0.000	3100.	0.	0.000	0.	1551.	5.55	285.	1.000	3	1716.	
0.	1.000	12935.	0.	11981.	0.926	166.3	0.000	3000.	0.	0.000	0.	1512.	5.24	285.	1.000	3	1695.	
0.	1.000	11797.	0.	10928.	0.926	158.8	0.000	2900.	0.	0.000	0.	1472.	4.93	285.	1.000	2	1673.	
0.	1.000	10679.	0.	9922.	0.929	151.2	0.000	2800.	0.	0.000	0.	1432.	4.63	285.	1.000	2	1651.	
0.	1.000	9594.	0.	8971.	0.935	143.6	0.000	2700.	0.	0.000	0.	1393.	4.33	285.	1.000	2	1629.	
0.	1.000	8559.	0.	8083.	0.944	136.2	0.000	2600.	0.	0.000	0.	1353.	4.04	285.	1.000	2	1606.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 10000.00,  
NM= 1,  
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Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	1.200	12725.	0.	12514.	0.983	180.6	0.000	3200.	0.	0.000	0.	1591.	7.51	285.	1.000	3	1737.
10000.	1.200	11773.	0.	11525.	0.979	173.6	0.000	3100.	0.	0.000	0.	1551.	7.12	285.	1.000	3	1716.
10000.	1.200	10830.	0.	10568.	0.976	166.4	0.000	3000.	0.	0.000	0.	1511.	6.72	285.	1.000	3	1695.
10000.	1.200	9888.	0.	9638.	0.975	158.9	0.000	2900.	0.	0.000	0.	1472.	6.33	285.	1.000	3	1673.
10000.	1.200	8967.	0.	8752.	0.976	151.3	0.000	2800.	0.	0.000	0.	1432.	5.93	285.	1.000	2	1651.
10000.	1.200	8074.	0.	7913.	0.980	143.7	0.000	2700.	0.	0.000	0.	1393.	5.55	285.	1.000	2	1629.
10000.	1.200	7222.	0.	7129.	0.987	136.2	0.000	2600.	0.	0.000	0.	1353.	5.18	285.	1.000	3	1606.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

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&D
ALT= 10000.00,
NM= 1,
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TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine
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ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	1.000	12284.	0.	11103.	0.904	196.3	0.000	3200.	0.	0.000	0.	1567.	6.55	285.	1.000	3	1724.
10000.	1.000	11400.	0.	10241.	0.898	188.9	0.000	3100.	0.	0.000	0.	1527.	6.21	285.	1.000	2	1703.
10000.	1.000	10536.	0.	9415.	0.894	181.5	0.000	3000.	0.	0.000	0.	1487.	5.88	285.	1.000	2	1682.
10000.	1.000	9694.	0.	8626.	0.890	174.0	0.000	2900.	0.	0.000	0.	1447.	5.55	285.	1.000	2	1660.
10000.	1.000	8856.	0.	7865.	0.888	166.3	0.000	2800.	0.	0.000	0.	1407.	5.23	285.	1.000	4	1637.
10000.	1.000	8012.	0.	7123.	0.889	158.1	0.000	2700.	0.	0.000	0.	1367.	4.89	285.	1.000	3	1614.
10000.	1.000	7183.	0.	6416.	0.893	149.9	0.000	2600.	0.	0.000	0.	1327.	4.57	285.	1.000	4	1591.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

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&D
ALT= 10000.00,
NM= 1,
XMA(1)= 0.800,
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TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine
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1 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.800	11996.	0.	10003.	0.834	211.3	0.000	3200.	0.	0.000	0.	1548.	5.82	285.	1.000	3	1714.
10000.	0.800	11145.	0.	9221.	0.827	203.3	0.000	3100.	0.	0.000	0.	1508.	5.51	285.	1.000	3	1693.
10000.	0.800	10333.	0.	8488.	0.821	195.4	0.000	3000.	0.	0.000	0.	1467.	5.22	285.	1.000	2	1671.
10000.	0.800	9531.	0.	7785.	0.817	187.5	0.000	2900.	0.	0.000	0.	1427.	4.93	285.	1.000	2	1648.
10000.	0.800	8752.	0.	7116.	0.813	179.6	0.000	2800.	0.	0.000	0.	1387.	4.65	285.	1.000	3	1625.
10000.	0.800	7984.	0.	6475.	0.811	171.5	0.000	2700.	0.	0.000	0.	1346.	4.37	285.	1.000	3	1602.
10000.	0.800	7209.	0.	5851.	0.812	163.0	0.000	2600.	0.	0.000	0.	1306.	4.09	285.	1.000	2	1578.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

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&D
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NM= 1,
XMA(1)= 0.600,
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TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine
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ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.600	11911.	0.	9184.	0.771	224.9	0.000	3193.	0.	0.000	0.	1532.	5.28	285.	1.000	7	1706.
10000.	0.600	11054.	0.	8429.	0.763	215.7	0.000	3093.	0.	0.000	0.	1490.	4.99	285.	1.000	12	1683.
10000.	0.600	10245.	0.	7745.	0.756	207.1	0.000	2993.	0.	0.000	0.	1450.	4.72	285.	1.000	5	1661.
10000.	0.600	9472.	0.	7104.	0.750	198.7	0.000	2893.	0.	0.000	0.	1409.	4.46	285.	1.000	3	1638.
10000.	0.600	8719.	0.	6497.	0.745	190.4	0.000	2793.	0.	0.000	0.	1368.	4.20	285.	1.000	3	1615.
10000.	0.600	7980.	0.	5918.	0.742	182.0	0.000	2693.	0.	0.000	0.	1328.	3.95	285.	1.000	3	1591.
10000.	0.600	7250.	0.	5363.	0.740	173.5	0.000	2593.	0.	0.000	0.	1287.	3.71	285.	1.000	4	1566.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

**&D**  
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 NM= 1,  
 XMA(1)= 0.400,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.400	11167.	0.	7838.	0.702	225.0	0.000	3076.	0.	0.000	0.	1474.	4.61	285.	1.000	2	1674.	
10000.	0.400	10333.	0.	7169.	0.694	215.4	0.000	2976.	0.	0.000	0.	1432.	4.35	285.	1.000	12	1651.	
10000.	0.400	9560.	0.	6567.	0.687	206.5	0.000	2876.	0.	0.000	0.	1391.	4.10	285.	1.000	4	1628.	
10000.	0.400	8808.	0.	6000.	0.681	197.8	0.000	2776.	0.	0.000	0.	1350.	3.87	285.	1.000	3	1604.	
10000.	0.400	8078.	0.	5463.	0.676	189.0	0.000	2676.	0.	0.000	0.	1309.	3.64	285.	1.000	3	1580.	
10000.	0.400	7358.	0.	4951.	0.673	180.2	0.000	2576.	0.	0.000	0.	1268.	3.41	285.	1.000	3	1555.	
10000.	0.400	6650.	0.	4459.	0.671	171.1	0.000	2476.	0.	0.000	0.	1227.	3.18	285.	1.000	2	1530.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

**&D**  
 ALT= 10000.00,  
 NM= 1,  
 XMA(1)= 0.200,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

1 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.200	11118.	0.	7111.	0.640	225.1	0.000	3007.	0.	0.000	0.	1439.	4.24	285.	1.000	1	1655.	
10000.	0.200	10293.	0.	6492.	0.631	215.3	0.000	2907.	0.	0.000	0.	1397.	4.00	285.	1.000	12	1631.	
10000.	0.200	9521.	0.	5934.	0.623	206.2	0.000	2807.	0.	0.000	0.	1356.	3.77	285.	1.000	4	1607.	
10000.	0.200	8766.	0.	5407.	0.617	197.2	0.000	2707.	0.	0.000	0.	1315.	3.54	285.	1.000	5	1583.	
10000.	0.200	8030.	0.	4909.	0.611	188.1	0.000	2607.	0.	0.000	0.	1274.	3.33	285.	1.000	4	1558.	
10000.	0.200	7307.	0.	4435.	0.607	179.0	0.000	2507.	0.	0.000	0.	1232.	3.11	285.	1.000	4	1533.	
10000.	0.200	6593.	0.	3983.	0.604	169.7	0.000	2407.	0.	0.000	0.	1191.	2.90	285.	1.000	3	1508.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

**&D**  
 ALT= 10000.00,  
 NM= 1,  
 XMA(1)= 0.000,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.000	11787.	0.	6868.	0.583	224.9	0.000	2982.	0.	0.000	0.	1426.	4.12	285.	1.000	1	1648.	
10000.	0.000	10922.	0.	6262.	0.573	215.1	0.000	2882.	0.	0.000	0.	1384.	3.88	285.	1.000	6	1624.	
10000.	0.000	10126.	0.	5721.	0.565	205.9	0.000	2782.	0.	0.000	0.	1343.	3.66	285.	1.000	4	1600.	
10000.	0.000	9342.	0.	5208.	0.558	196.7	0.000	2682.	0.	0.000	0.	1302.	3.43	285.	1.000	4	1575.	
10000.	0.000	8578.	0.	4723.	0.551	187.6	0.000	2582.	0.	0.000	0.	1261.	3.22	285.	1.000	3	1551.	
10000.	0.000	7825.	0.	4262.	0.545	178.4	0.000	2482.	0.	0.000	0.	1220.	3.01	285.	1.000	3	1525.	
10000.	0.000	7082.	0.	3824.	0.540	169.1	0.000	2382.	0.	0.000	0.	1178.	2.80	285.	1.000	4	1500.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

**&D**  
 ALT= 20000.00,  
 NM= 1,  
 XMA(1)= 1.200,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
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20000.	1.200	10092.	0.	9609.	0.952	197.6	0.000	3200.	0.	0.000	0.	1566.	8.46	285.	1.000	5	1724.
20000.	1.200	9369.	0.	8862.	0.946	190.2	0.000	3100.	0.	0.000	0.	1525.	8.03	285.	1.000	3	1702.
20000.	1.200	8666.	0.	8149.	0.940	182.7	0.000	3000.	0.	0.000	0.	1485.	7.60	285.	1.000	3	1681.
20000.	1.200	7979.	0.	7469.	0.936	175.2	0.000	2900.	0.	0.000	0.	1445.	7.18	285.	1.000	3	1659.
20000.	1.200	7300.	0.	6812.	0.933	167.5	0.000	2800.	0.	0.000	0.	1405.	6.76	285.	1.000	3	1636.
20000.	1.200	6617.	0.	6171.	0.933	159.4	0.000	2700.	0.	0.000	0.	1365.	6.33	285.	1.000	3	1613.
20000.	1.200	5946.	0.	5559.	0.935	151.0	0.000	2600.	0.	0.000	0.	1325.	5.91	285.	1.000	3	1589.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

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&D
ALT= 20000.00,
NM= 1,
XMA(1)= 1.000,
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TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine
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1 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
20000.	1.000	9712.	0.	8533.	0.879	215.1	0.000	3200.	0.	0.000	0.	1544.	7.39	285.	1.000	3	1712.	
20000.	1.000	9030.	0.	7866.	0.871	206.9	0.000	3100.	0.	0.000	0.	1504.	7.01	285.	1.000	4	1690.	
20000.	1.000	8373.	0.	7238.	0.864	198.8	0.000	3000.	0.	0.000	0.	1463.	6.64	285.	1.000	2	1668.	
20000.	1.000	7726.	0.	6637.	0.859	190.8	0.000	2900.	0.	0.000	0.	1423.	6.27	285.	1.000	3	1646.	
20000.	1.000	7102.	0.	6070.	0.855	182.8	0.000	2800.	0.	0.000	0.	1382.	5.91	285.	1.000	3	1623.	
20000.	1.000	6490.	0.	5526.	0.851	174.6	0.000	2700.	0.	0.000	0.	1342.	5.56	285.	1.000	3	1599.	
20000.	1.000	5878.	0.	4998.	0.850	166.2	0.000	2600.	0.	0.000	0.	1301.	5.21	285.	1.000	2	1575.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

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&D
ALT= 20000.00,
NM= 1,
XMA(1)= 0.800,
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TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine
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ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
20000.	0.800	8927.	0.	7208.	0.807	224.8	0.000	3113.	0.	0.000	0.	1492.	6.30	285.	1.000	2	1684.	
20000.	0.800	8259.	0.	6600.	0.799	215.4	0.000	3013.	0.	0.000	0.	1450.	5.94	285.	1.000	12	1661.	
20000.	0.800	7641.	0.	6053.	0.792	206.7	0.000	2913.	0.	0.000	0.	1410.	5.61	285.	1.000	6	1638.	
20000.	0.800	7040.	0.	5538.	0.787	198.0	0.000	2813.	0.	0.000	0.	1369.	5.29	285.	1.000	3	1615.	
20000.	0.800	6459.	0.	5051.	0.782	189.4	0.000	2713.	0.	0.000	0.	1328.	4.98	285.	1.000	4	1591.	
20000.	0.800	5888.	0.	4585.	0.779	180.7	0.000	2613.	0.	0.000	0.	1287.	4.68	285.	1.000	3	1567.	
20000.	0.800	5325.	0.	4139.	0.777	171.8	0.000	2513.	0.	0.000	0.	1246.	4.37	285.	1.000	4	1542.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 20000.00,
NM= 1,
XMA(1)= 0.600,
NP=7,
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine
```

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
20000.	0.600	7922.	0.	5824.	0.735	224.8	0.000	2960.	0.	0.000	0.	1416.	5.25	285.	1.000	6	1642.	
20000.	0.600	7296.	0.	5308.	0.728	214.9	0.000	2860.	0.	0.000	0.	1374.	4.94	285.	1.000	6	1618.	
20000.	0.600	6721.	0.	4846.	0.721	205.6	0.000	2760.	0.	0.000	0.	1333.	4.65	285.	1.000	4	1594.	
20000.	0.600	6155.	0.	4407.	0.716	196.4	0.000	2660.	0.	0.000	0.	1291.	4.37	285.	1.000	3	1569.	
20000.	0.600	5608.	0.	3993.	0.712	187.2	0.000	2560.	0.	0.000	0.	1250.	4.10	285.	1.000	3	1544.	
20000.	0.600	5071.	0.	3600.	0.710	177.9	0.000	2460.	0.	0.000	0.	1209.	3.82	285.	1.000	3	1519.	
20000.	0.600	4545.	0.	3227.	0.710	168.5	0.000	2360.	0.	0.000	0.	1168.	3.55	285.	1.000	3	1493.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 20000.00,
```

NM= 1,  
 XMA(1)= 0.400,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

1 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
20000.	0.400	7416.	0.	4971.	0.670	224.9	0.000	2852.	0.	0.000	0.	1361.	4.59	285.	1.000	1	1610.	
20000.	0.400	6815.	0.	4513.	0.662	214.5	0.000	2752.	0.	0.000	0.	1319.	4.31	285.	1.000	5	1586.	
20000.	0.400	6257.	0.	4103.	0.656	204.8	0.000	2652.	0.	0.000	0.	1277.	4.04	285.	1.000	4	1560.	
20000.	0.400	5710.	0.	3716.	0.651	195.1	0.000	2552.	0.	0.000	0.	1236.	3.79	285.	1.000	4	1535.	
20000.	0.400	5181.	0.	3352.	0.647	185.5	0.000	2452.	0.	0.000	0.	1194.	3.53	285.	1.000	3	1510.	
20000.	0.400	4667.	0.	3009.	0.645	175.9	0.000	2352.	0.	0.000	0.	1153.	3.29	285.	1.000	3	1484.	
20000.	0.400	4162.	0.	2683.	0.645	166.2	0.000	2252.	0.	0.000	0.	1112.	3.04	285.	1.000	3	1459.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 30000.00,  
 NM= 1,  
 XMA(1)= 1.200,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
30000.	1.200	7819.	0.	7230.	0.925	218.3	0.000	3200.	0.	0.000	0.	1541.	9.66	285.	1.000	8	1710.	
30000.	1.200	7264.	0.	6660.	0.917	209.9	0.000	3100.	0.	0.000	0.	1500.	9.15	285.	1.000	5	1688.	
30000.	1.200	6740.	0.	6127.	0.909	201.7	0.000	3000.	0.	0.000	0.	1459.	8.66	285.	1.000	4	1666.	
30000.	1.200	6228.	0.	5624.	0.903	193.5	0.000	2900.	0.	0.000	0.	1419.	8.18	285.	1.000	2	1644.	
30000.	1.200	5727.	0.	5142.	0.898	185.4	0.000	2800.	0.	0.000	0.	1378.	7.72	285.	1.000	2	1621.	
30000.	1.200	5241.	0.	4683.	0.893	177.2	0.000	2700.	0.	0.000	0.	1338.	7.26	285.	1.000	3	1597.	
30000.	1.200	4759.	0.	4240.	0.891	168.8	0.000	2600.	0.	0.000	0.	1297.	6.81	285.	1.000	4	1573.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 30000.00,  
 NM= 1,  
 XMA(1)= 1.000,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
30000.	1.000	6769.	0.	5713.	0.844	224.9	0.000	3050.	0.	0.000	0.	1461.	7.82	285.	1.000	2	1667.	
30000.	1.000	6253.	0.	5222.	0.835	215.3	0.000	2950.	0.	0.000	0.	1419.	7.37	285.	1.000	11	1644.	
30000.	1.000	5765.	0.	4778.	0.829	206.3	0.000	2850.	0.	0.000	0.	1378.	6.94	285.	1.000	4	1620.	
30000.	1.000	5302.	0.	4363.	0.823	197.5	0.000	2750.	0.	0.000	0.	1337.	6.54	285.	1.000	3	1596.	
30000.	1.000	4851.	0.	3968.	0.818	188.6	0.000	2650.	0.	0.000	0.	1296.	6.15	285.	1.000	3	1572.	
30000.	1.000	4409.	0.	3592.	0.815	179.7	0.000	2550.	0.	0.000	0.	1255.	5.76	285.	1.000	3	1547.	
30000.	1.000	3975.	0.	3233.	0.813	170.5	0.000	2450.	0.	0.000	0.	1214.	5.37	285.	1.000	4	1522.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 30000.00,  
 NM= 1,  
 XMA(1)= 0.800,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

1 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
----------	------	----	------	----	------	-----	------	-----	-----	-----	------	-----	----	-----	----	----	-----	----

30000.	0.800	5746.	0.	4412.	0.768	224.9	0.000	2870.	0.	0.000	0.	1370.	6.27	285.	1.000	2	1616.
30000.	0.800	5272.	0.	4008.	0.760	214.6	0.000	2770.	0.	0.000	0.	1328.	5.89	285.	1.000	6	1591.
30000.	0.800	4832.	0.	3645.	0.754	205.0	0.000	2670.	0.	0.000	0.	1286.	5.53	285.	1.000	5	1566.
30000.	0.800	4409.	0.	3304.	0.749	195.4	0.000	2570.	0.	0.000	0.	1245.	5.18	285.	1.000	3	1541.
30000.	0.800	3998.	0.	2982.	0.746	185.8	0.000	2470.	0.	0.000	0.	1203.	4.84	285.	1.000	3	1515.
30000.	0.800	3600.	0.	2679.	0.744	176.3	0.000	2370.	0.	0.000	0.	1162.	4.50	285.	1.000	3	1490.
30000.	0.800	3210.	0.	2391.	0.745	166.6	0.000	2270.	0.	0.000	0.	1121.	4.17	285.	1.000	3	1464.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D

ALT= 30000.00,  
 NM= 1,  
 XMA(1)= 0.600,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
30000.	0.600	5099.	0.	3571.	0.700	225.0	0.000	2732.	0.	0.000	0.	1299.	5.24	285.	1.000	1	1574.	
30000.	0.600	4656.	0.	3227.	0.693	214.0	0.000	2632.	0.	0.000	0.	1257.	4.90	285.	1.000	12	1548.	
30000.	0.600	4244.	0.	2918.	0.688	203.7	0.000	2532.	0.	0.000	0.	1215.	4.58	285.	1.000	3	1522.	
30000.	0.600	3850.	0.	2631.	0.683	193.7	0.000	2432.	0.	0.000	0.	1173.	4.27	285.	1.000	3	1497.	
30000.	0.600	3471.	0.	2362.	0.681	183.7	0.000	2332.	0.	0.000	0.	1131.	3.97	285.	1.000	4	1471.	
30000.	0.600	3104.	0.	2110.	0.680	173.8	0.000	2232.	0.	0.000	0.	1090.	3.68	285.	1.000	3	1445.	
30000.	0.600	2740.	0.	1868.	0.682	163.4	0.000	2132.	0.	0.000	0.	1049.	3.39	285.	1.000	3	1418.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D

ALT= 40000.00,  
 NM= 1,  
 XMA(1)= 1.200,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
40000.	1.200	5130.	0.	4620.	0.901	224.9	0.000	3100.	0.	0.000	0.	1486.	10.02	285.	1.000	15	1681.	
40000.	1.200	4743.	0.	4228.	0.891	215.4	0.000	3000.	0.	0.000	0.	1444.	9.45	285.	1.000	12	1658.	
40000.	1.200	4385.	0.	3876.	0.884	206.6	0.000	2900.	0.	0.000	0.	1403.	8.92	285.	1.000	4	1635.	
40000.	1.200	4038.	0.	3545.	0.878	197.9	0.000	2800.	0.	0.000	0.	1362.	8.41	285.	1.000	4	1611.	
40000.	1.200	3703.	0.	3230.	0.872	189.3	0.000	2700.	0.	0.000	0.	1321.	7.92	285.	1.000	4	1587.	
40000.	1.200	3376.	0.	2931.	0.868	180.5	0.000	2600.	0.	0.000	0.	1280.	7.43	285.	1.000	3	1562.	
40000.	1.200	3057.	0.	2643.	0.864	171.6	0.000	2500.	0.	0.000	0.	1239.	6.94	285.	1.000	2	1538.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D

ALT= 40000.00,  
 NM= 1,  
 XMA(1)= 1.000,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine

1 Regenerative Turboshaft Engine

40000.	1.000	4213.	0.	3443.	0.817	225.1	0.000	2893.	0.	0.000	0.	1382.	7.80	285.	1.000	11	1622.
40000.	1.000	3870.	0.	3131.	0.809	214.9	0.000	2793.	0.	0.000	0.	1339.	7.33	285.	1.000	12	1598.
40000.	1.000	3551.	0.	2849.	0.802	205.3	0.000	2693.	0.	0.000	0.	1298.	6.88	285.	1.000	4	1573.
40000.	1.000	3241.	0.	2584.	0.797	195.8	0.000	2593.	0.	0.000	0.	1256.	6.45	285.	1.000	3	1548.
40000.	1.000	2943.	0.	2335.	0.793	186.3	0.000	2493.	0.	0.000	0.	1215.	6.03	285.	1.000	3	1522.
40000.	1.000	2654.	0.	2099.	0.791	176.8	0.000	2393.	0.	0.000	0.	1173.	5.62	285.	1.000	3	1497.
40000.	1.000	2372.	0.	1876.	0.791	167.2	0.000	2293.	0.	0.000	0.	1132.	5.21	285.	1.000	3	1472.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D

ALT= 40000.00,

```

NM= 1,
XMA(1)= 0.800,
NP=7,
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine

ALTITUDE MACH FN BSHP WF TSFC REF FLOW BPR BOT T19 PR19 A19 T9 PR9 A9 RR NIT V9
40000. 0.800 4073. 0. 4303. 1.056 245.9 0.000 3200. 0. 0.000 0. 1417. 6.94 285. 1.000 25 1642.
NEGATIVE THRUST OR NO CONVERGENCE FOR M= 0

NAMELIST INPUT CARDS FOR NEXT SOLUTION
&D ENDRUN=1 &END

```

## Sample Problem 2—Modifying an Existing NAMELIST Input

### *QDATGEN Terminal Session*

The following is a sample terminal session used to modify the QNEP input for the regenerative turboshaft configuration in the preceding example. (See fig. C2.) Therefore option -1 “Modify an existing design point namelist input,” is selected. In this example the inlet pressure recovery is allowed to vary according to the default table data. The engine mass flow is sized for 20 000 lb thrust in the design point mode using a control. In the off-design mode of operation, a fixed turbine pressure ratio is simulated rather than a normal fixed nozzle exit area. To achieve this operation the control varying the turbine pressure ratio to satisfy the nozzle interface relative flow error, assigned in the previous example, and the design point control used to size the mass flow to 20 000 lb thrust are turned off. To account for the nozzle interface relative flow error, the nozzle switch is set to float the nozzle area to accept whatever mass flow the turbine is passing to it. In effect this is simulating a variable-area nozzle. Off-design point input data are generated for Mach number and altitude combinations between 500 and 1500 psf at increments of 0.2 and 10 000 ft, respectively. The maximum allowable Mach number is 1.2 and the maximum allowable altitude is 40 000 ft. Additional points at low dynamic pressure are also generated. In order to improve QNEP reliability the QNEP input data are cycled from low Mach number to high Mach number and back for each successive altitude. The “-O” command line option is used to override the default output file name. The following,

“QDATGEN -O CASE2.INP”

is entered to start.

QDATGEN; PC version: 1.21

This program allows the interactive generation of an input file written in namelist format, for use in QNEP, a special version of NEPCOMP II. The user should already be familiar with QNEP and should have a schematic diagram of the engine to be modeled on hand.

The QDATGEN output file will default to "TAPE5" ....  
the default can be changed from the command line by entering  
QDATGEN -O [filename].

Press Enter to Continue.

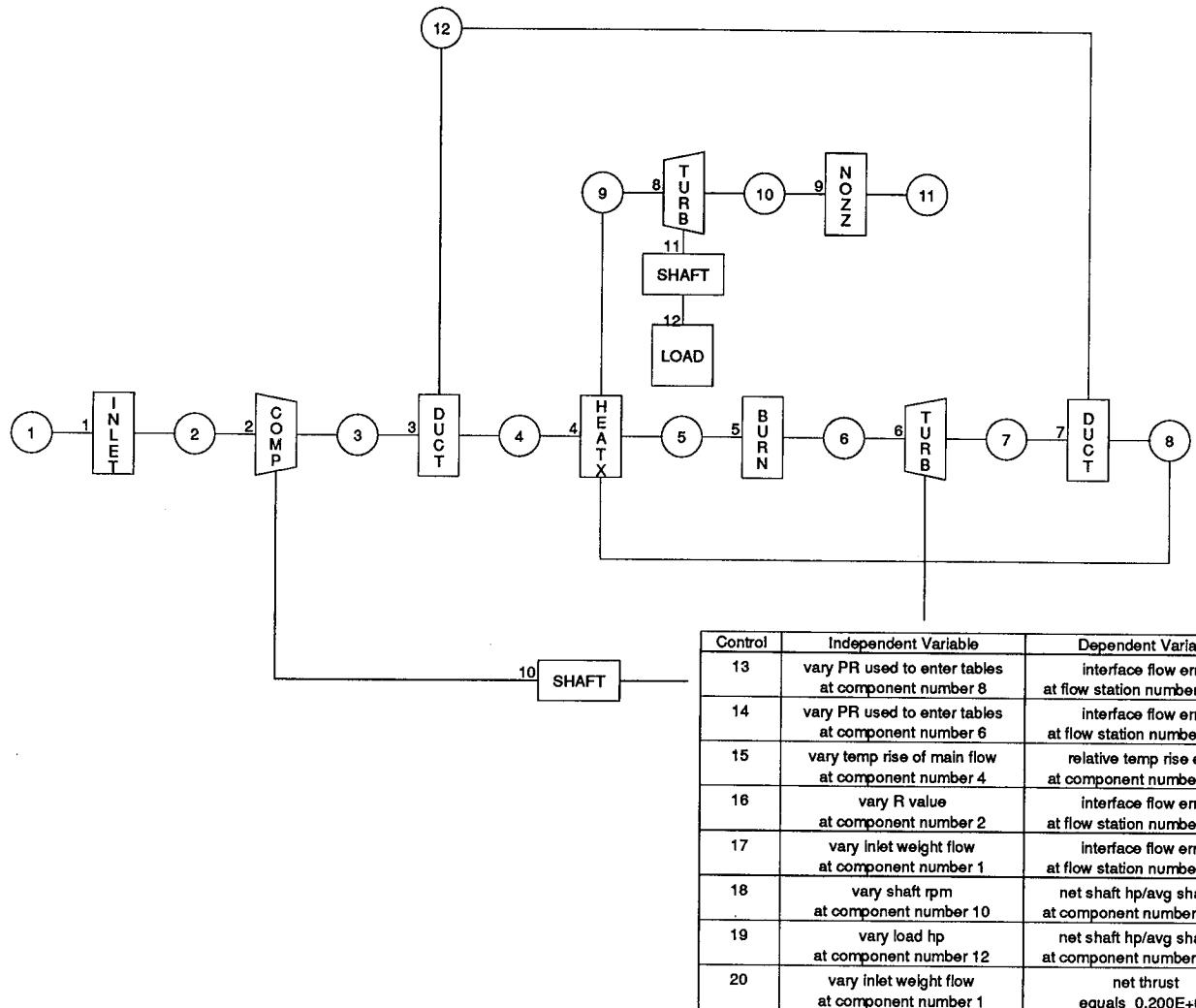


Figure C2. Regenerative turboshaft configuration for sample problem 2.

Select engine to be modeled...

- 1 = Modify an existing design point namelist input.
- 0 = User specified engine.
- 1 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through the lp rotor.
- 2 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through a lp fan only.  
This engine requires 3 compressor components.
- 3 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through a lp fan to a fan nozzle.  
This engine requires 3 compressor components.
- 4 = Dual-rotor turbojet with or without afterburning.
- 5 = Single-rotor turbojet with or without afterburning.
- 6 = Dual-rotor turbofan with or without afterburning.  
Bypass airflow passes through a lp fan to a fan nozzle.  
This engine requires 2 compressor components.
- 7 = Ramjet

>>-1

Enter the file name.  
>>CASE1.INP

Component number 1 is a Inlet

1 - Inlet weight flow, lbs/sec	225.00
2 - Freestream static temperature, R	0.00
3 - Freestream static pressure, psi	0.00
4 - Inlet drag D/(q*SF)	0.00
5 - Inlet freestream Mach number	0.00
6 - Pressure recovery	1.00
7 - Maximum permitted referred flow	100.00
8 - Scale factor on referred flow	1.00
9 - Altitude as input, ft.	0.00
10 - Freestream fuel:air ratio	0.00
11 - Switch (0-geom alt; 1-geop alt)	0.00
12 - Reference area, in*in	0.00
13 - Scale factor on inlet drag	0.00

Enter number, value (Rtn for next comp; 15,15 to end)

>>1 300

>>6 11

>>

Component number 2 is a Compressor

1 - "R" value	2.00
2 - Fraction of main flow leaving as bleed flow	0.00
3 - Scalar multiplier on referred speed	1.00
4 - Referred flow used to enter tables	701.00
5 - Scale factor on referred flow	1.00
6 - Adiabatic efficiency	702.00
7 - Scale factor on adiabatic efficiency	1.00
8 - Compressor pressure ratio	703.00
9 - Scalar multiplier on pressure ratio	1.00
10 - Value of third argument	0.00
11 - Fractional bleed horsepower loss	0.00
12 - Design point adiabatic efficiency	0.87
13 - Design point pressure ratio	12.00
14 - Design point referred speed	1.00

Enter number, value (Rtn for next comp; 15,15 to end)

>>

Component number 3 is a Duct, Burner, or A/B

1 - Delta p/p momentum pressure drop	0.05
2 - Design point Mach number	0.00
3 - Coefficient on corrected flow squared	0.00
4 - Burner outlet temperature, R	0.00
5 - Burner efficiency	0.00
6 - Fuel heating value, btu/lb	0.00
7 - Cross sectional area, in*in	0.00
8 - Fraction of bleed flow entering 2-nd inlet	0.00
9 - Fraction of main exit directed to bleed exit	0.05

Enter number, value (Rtn for next comp; 15,15 to end)

>>

Component number 4 is a Heat exchanger

1 - Delta p/p, main flow stream	0.05
2 - Delta p/p, secondary flow stream	0.05
3 - Temperature rise of main flow	1500.00
4 - Heat exchanger effectiveness	0.90
5 - Scale factor on heat exchanger effectiveness	1.00

Enter number, value (Rtn for next comp; 15,15 to end)

>>

Component number 5 is a Duct, Burner, or A/B

1 - Delta p/p momentum pressure drop	0.05
2 - Design point Mach number	0.00
3 - Coefficient on corrected flow squared	0.00
4 - Burner outlet temperature, R	3200.00
5 - Burner efficiency	0.95

6 - Fuel heating value, btu/lb	18500.00
7 - Cross sectional area, in*in	0.00
8 - Fraction of bleed flow entering 2-nd inlet	0.00
9 - Fraction of main exit directed to bleed exit	0.00

Enter number, value (Rtn for next comp; 15,15 to end)  
 >>

Component number 6 is a Turbine

1 - Pressure ratio used to enter tables	3.00
2 - Fraction of bleed flow entering the turbine	0.00
3 - Scalar multiplier on referred speed	1.00
4 - Referred flow	121.00
5 - Scale factor on referred flow	1.00
6 - Adiabatic efficiency	122.00
7 - Scale factor on adiabatic efficiency	1.00
8 - Scalar multiplier on pressure ratio	1.00
9 - Fraction of bleed entering the front	0.00
10 - Value of third argument	63.00
11 - Design point adiabatic efficiency	0.92
12 - Design point referred speed	100.00
13 - Turbine horsepower split factor	1.00

Enter number, value (Rtn for next comp; 15,15 to end)

>>

Component number 7 is a Duct, Burner, or A/B

1 - Delta p/p momentum pressure drop	0.02
2 - Design point Mach number	0.00
3 - Coefficient on corrected flow squared	0.00
4 - Burner outlet temperature, R	0.00
5 - Burner efficiency	0.00
6 - Fuel heating value, btu/lb	0.00
7 - Cross sectional area, in*in	0.00
8 - Fraction of bleed flow entering 2-nd inlet	1.00
9 - Fraction of main exit directed to bleed exit	0.00

Enter number, value (Rtn for next comp; 15,15 to end)

>>

Component number 8 is a Turbine

1 - Pressure ratio used to enter tables	3.00
2 - Fraction of bleed flow entering the turbine	0.00
3 - Scalar multiplier on referred speed	1.00
4 - Referred flow	121.00
5 - Scale factor on referred flow	1.00
6 - Adiabatic efficiency	122.00
7 - Scale factor on adiabatic efficiency	1.00
8 - Scalar multiplier on pressure ratio	1.00
9 - Fraction of bleed entering the front	0.00
10 - Value of third argument	63.00
11 - Design point adiabatic efficiency	0.92
12 - Design point referred speed	100.00
13 - Turbine horsepower split factor	1.00

Enter number, value (Rtn for next comp; 15,15 to end)

>>

Component number 9 is a Nozzle

1 - Nozzle flow area, in*in	300.00
2 - Nozzle flow coefficient	0.98
3 - Aftend drag D/(q*SF)	0.00
4 - Ambient exit static pressure,psi	0.00
5 - Nozzle velocity (or thrust coefficient)	0.98
6 - Switch (0:C; 1:C-D)	0.00
7 - Switch (0:fixed; 1:variable)	0.00
8 - Nozzle exit:throat area ratio	0.00
9 - Inlet component number	1.00
10 - Scale factor on drag	0.00

Enter number, value (Rtn for next comp; 15,15 to end)

```
>>7 1
>>

Component number 10 is a Shaft

1 - Actual shaft speed, R.P.M.          1.00
2 - Gear ratio of first connected component 1.00
3 - Mechanical efficiency of the first component 1.00
4 - Gear ratio of second connected component 1.00
5 - Mechanical efficiency of the second component 1.00
6 - Gear ratio of third connected component 0.00
7 - Mechanical efficiency of the third component 0.00
8 - Gear ratio of fourth connected component 0.00
9 - Mechanical efficiency of the fourth component 0.00
Enter number, value (Rtn for next comp; 15,15 to end)
>>
```

Component number 11 is a Shaft

```
1 - Actual shaft speed, R.P.M.          1.00
2 - Gear ratio of first connected component 1.00
3 - Mechanical efficiency of the first component 1.00
4 - Gear ratio of second connected component 1.00
5 - Mechanical efficiency of the second component 1.00
6 - Gear ratio of third connected component 0.00
7 - Mechanical efficiency of the third component 0.00
8 - Gear ratio of fourth connected component 0.00
9 - Mechanical efficiency of the fourth component 0.00
Enter number, value (Rtn for next comp; 15,15 to end)
>>
```

Component number 12 is a Load

```
1 - Load horsepower, h.P.   (- for work out) -250.00
2 - Switch    (1-hP summed in overall perf.) 0.00
Enter number, value (Rtn for next comp; 15,15 to end)
>>
```

Component number 13 is a Control

```
1 - Tolerance (0=OFF; 1=.001)          0.00
2 - Independent minimum                0.00
3 - Independent maximum                0.00
4 - Independent component              1.00
5 - Dependent variable's value        0.00
6 - Dependent variable (+0, +10, or +20) 8.00
Enter number, value (Rtn for next comp; 15,15 to end)
>>15 15
```

```
Enter the number of controls to be added (MAX=21).
>>1
Enter either the flow station number or the component number where
the control dependent variable is located (or zero).
-Flow station if the control dependent variable is a station
property output.
-Component number if the control dependent variable is a "DATOUT" variable.
```

-Zero if the control dependent variable is a performance property.

```
>>0
Enter the component number where the control independent variable
is located. Independent variable may only be one of the "CDAT" input
variables.
```

>>1

Component number 20 is a Control

```
Is this control active (Y/N) ?
>>Y
```

```

    Enter the desired tolerance (DEFAULT=.001).
>>
    Enter the minimum value of the independent variable (enter zero for
    no limit).
>>
    Enter the maximum value (zero for no limit).
>>
Which CDAT variable is the independent variable for the Inlet
designated by component number 1 for this control variable.
    1 - Inlet weight flow, lbs/sec
    2 - Freestream static temperature, R
    3 - Freestream static pressure, psi
    4 - Inlet drag D/(q*SF)
    5 - Inlet freestream Mach number
    6 - Pressure recovery
    7 - Maximum permitted referred flow
    8 - Scale factor on referred flow
    9 - Altitude as input, ft.
   10 - Freestream fuel:air ratio
   11 - Switch
   12 - Reference area, in*in
   13 - Scale factor on inlet drag
>>1
The dependent variable of control is:
    1 - Net thrust (lbs).
    2 - Brake SHP (hp).
    3 - Air flow (lbs/sec).
    4 - TSFC (lbs/hr/lb).
    5 - BSFS (lbs/hr/hp).
    6 - Fuel flow (lbs/hr).
    7 - Thrust:airflow ratio (lb-sec/lb).
    8 - Net BSHP:airflow ratio (hp-sec/lb).
    9 - Inlet drag (lbs).
>>1
Enter the desired value of the control dependent variable.
>>20000
Are the CDAT inputs correct up to this point (Y/N) ?
>>Y
Select one: 0 - Off design mode.
            1 - Design mode calculation sequence.
IDESN=1
>>
Select one: 0 - Regular solution print out.
            1 - Extra print diagnostics + regular.
            2 - Full convergence history + regular.
IPRINT=0
>>
Do you want a title card (Y/N) ?
>>Y
Enter title (one line max).
>>Regenerative Turbohaft Engine - Variable Exhaust Nozzle
Select one: 0 - No tabular data.
            1 - Tabular data.
            2 - Print tabular data.
>>1
Enter the scalar multiplier on table value of referred flow.
>>500
Enter the altitude (enter -1 to specify free stream static temperature
and pressure).
>>0
Do you want mach, thrust, and fuel flow in format compatible with
other performance codes (Y/N) ?
>>n
Enter the design burner outlet temperature.
>>3200
Default is the bot of the design point solution.
Are all the table data decks on one tape (Y/N) ?
>>y
Enter the file name.
>>deftab
Enter the number of runs desired.
>>2
Note: full data sets are treated as one run and

```

include any combination of constant dynamic pressure paths and constant altitude flight envelopes.

Changes to input data for case - 1

Do you want any changes in the input data (Y/N) ?

>>n

Note: controls associated with the design point should be deactivated here.

(default=NO)

Note: For a variable area nozzle the control on the nozzle interface relative flow error must be deactivated.

Do you want to reconsider (Y/N) ?

(default=NO)

>>y

Do you want any changes in the input data (Y/N) ?

Note: controls associated with the design point should be deactivated here.

(default=NO)

>>y

Component number	Component type	Component number	Component type
1 - Inlet		11 - Shaft	
2 - Compressor		12 - Load	
3 - Duct, Burner, or A/B		13 - Control	
4 - Heat exchanger		14 - Control	
5 - Duct, Burner, or A/B		15 - Control	
6 - Turbine		16 - Control	
7 - Duct, Burner, or A/B		17 - Control	
8 - Turbine		18 - Control	
9 - Nozzle		19 - Control	
10 - Shaft		20 - Control	

Enter the number of components requiring changes.

>>2

On one line enter the component numbers where changes are required.

>>13,20

In making changes to controls do you want only to turn them on or off (Y/N)?

>>y

Component number 13 is a Control

Is this control active (Y/N) ?

>>n

Component number 20 is a Control

Is this control active (Y/N) ?

>>n

Enter options (no spaces between entries)

A - Change altitude

M - Change mach numbers

T - Change throttle setting points

B - Change burner or afterburner inputs

W - Maximum weight flow

P - Change print controls

L - Change title

Q - Change tables

N - No further changes

Z - Change all inputs

S - Stop

>>mtp

Select one: 0 - Off design mode.

```

1 - Design mode calculation sequence.

IDESN=0
>>
Select one: 0 - Regular solution print out.
             1 - Extra print diagnostics + regular.
             2 - Full convergence history + regular.

IPRINT=0
>>
Enter the number of mach numbers to be run at the current altitude
(MAX=16).
>>1
On one line enter the Mach numbers.

>>0
Enter the number of throttle setting points to be run at the current
altitude (7=MAX).
>>1
Do you want mach, thrust, and fuel flow in format compatible with
other performance codes (Y/N) ?
>>n
Do you want to generate a complete set of data (Y/N) ?
>>y
Do you want cycle the input to improve QNEP reliability (y/n) ?
>>y
Do you want to generate the data deck for constant
dynamic pressure paths (y/n) ?
>>n
Enter the starting altitude.
>>0
Enter the ending altitude.
>>40000
Enter the increment in altitude.
>>10000
Enter the minimum dynamic pressure (psf).
>>500
Enter the maximum dynamic pressure.
>>1500
At low altitudes and mach numbers the dynamic pressure may be less than
the minimum. For example if the dynamic pressure is less than the
minimum and the altitude is less than Mach*Slope+Intercept, data will
be computed for that point.
Enter the slope.
>>10000
Enter the intercept.
>>10000
Enter the number of throttle setting points to be run at point (MAX=7).
>>7
Enter the increments between throttle setting points (MAX=6).
>>6*100
Enter the increment between mach numbers.
>>.2
Enter the maximum allowable mach number (multiple of increment).
>>1.2
Enter the minimum allowable mach number (multiple of increment).
>>0
Is this data deck being run non-afterburning (Y/N) ?
>>y
Enter the maximum turbine inlet temperature (R).
(or burner outlet temperature)
>>3200
Do you want to cycle the throttle setting points (y/n) ?
>>n
Another full data set (y/n) ?
>>n

```

The input file to QNEP has been written to CASE2.INP.  
There are a total of 17 &D NAMELIST input cases  
including design point cases.

### *QNEP Terminal Session*

After the input file is generated it is edited by inserting the following termination card at the end of the table data so that QNEP stops after the design point is complete:

```
"&D ENDRUN=1 &END"
```

After this modification, the purpose of which is to obtain a value for WMAX, QNEP is run with the following options:

```
qnepl -i case2.inp -o design.dat -n=100
```

The screen appears as follows upon completion of the design point:

```
QNEP; PC version: 1.40

Design point complete.....
Done...

Total Elapsed Time is 0 minutes 27 seconds
```

Next the input file is edited. The maximum referred flow, based upon the results of the design point run, is set to 285 and the termination card is removed. QNEP is rerun with the following options:

```
qnepl -i case2.inp -o case2.dat -n=20
```

The screen appears as follows upon completion:

```
QNEP; PC version: 1.40

Design point complete.....
Done...

Total number of good points = 113

Total Elapsed Time is 19 minutes 59 seconds

Number of points/min = 5.7
```

The QNEP output file begins on the next page. In order to save space the table data, which are unchanged from the first sample case, have been omitted.

## NAVAL AIR DEVELOPMENT CENTER

NEPII NAVY ENGINE PERFORMANCE COMPUTER CODE  
MODIFIED VERSION 1.00 - IBM PC OR COMPATIBLE

## NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
IPRINT=0,  
NCOMP=20,  
NOSTAT=12,  
IDESN=1,  
TABLES=1.,  
FIGSET=1.,  
JFIG(1, 1)= 1, 1, 0, 2, 0,  
JFIG(1, 2)= 4, 2, 0, 3, 0,  
JFIG(1, 3)= 2, 3, 0, 4, 12,  
JFIG(1, 4)= 6, 4, 8, 5, 9,  
JFIG(1, 5)= 2, 5, 0, 6, 0,  
JFIG(1, 6)= 5, 6, 0, 7, 0,  
JFIG(1, 7)= 2, 7, 12, 8, 0,  
JFIG(1, 8)= 5, 9, 0, 10, 0,  
JFIG(1, 9)= 9, 10, 0, 11, 0,  
JFIG(1,10)=11, 2, 6, 0, 0,  
JFIG(1,11)=11, 8, 12, 0, 0,  
JFIG(1,12)=10, 0, 0, 0, 0,  
JFIG(1,13)=12, 10, 0, 8, 0,  
JFIG(1,14)=12, 9, 0, 6, 0,  
JFIG(1,15)=12, 4, 0, 4, 0,  
JFIG(1,16)=12, 6, 0, 2, 0,  
JFIG(1,17)=12, 2, 0, 1, 0,  
JFIG(1,18)=12, 10, 0, 10, 0,  
JFIG(1,19)=12, 11, 0, 12, 0,  
JFIG(1,20)=12, 0, 0, 1, 0,  
CDAT( 1, 1)= 300.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              11.00000, 100.00000, 1.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 2)= 2.00000, 0.00000, 1.00000, 701.00000, 1.00000,  
              702.00000, 1.00000, 703.00000, 1.00000, 0.00000,  
              0.00000, 0.87000, 12.00000, 1.00000, 0.00000,  
CDAT( 1, 3)= 0.05000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.05000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 4)= 0.05000, 0.05000, 1500.00000, 0.90000, 1.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 5)= 0.05000, 0.00000, 0.00000, 3200.00000, 0.95000,  
              18500.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 6)= 3.00000, 0.00000, 1.00000, 121.00000, 1.00000,  
              122.00000, 1.00000, 1.00000, 0.00000, 63.00000,  
              0.92000, 100.00000, 1.00000, 0.00000, 0.00000,  
CDAT( 1, 7)= 0.02000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 1.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 8)= 3.00000, 0.00000, 1.00000, 121.00000, 1.00000,  
              122.00000, 1.00000, 1.00000, 0.00000, 63.00000,  
              0.92000, 100.00000, 1.00000, 0.00000, 0.00000,  
CDAT( 1, 9)= 300.00000, 0.98000, 0.00000, 0.00000, 0.98000,  
              0.00000, 1.00000, 0.00000, 1.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1,10)= 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1,11)= 1.00000, 1.00000, 1.00000, 1.00000, 1.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1,12)= -250.00000, 0.00000, 0.00000, 0.00000, 0.00000,

```

          0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
          0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,13)=  0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
              8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,14)=  0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
              8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,15)=  0.00000,   0.00000,   0.00000,   3.00000,   0.00000,
              18.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,16)=  0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
              8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,17)=  0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
              8.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,18)=  0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
              18.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,19)=  0.00000,   0.00000,   0.00000,   1.00000,   0.00000,
              18.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
CDAT( 1,20)=  1.00000,   0.00000,   0.00000,   1.00000, 20000.00000,
              21.00000,   0.00000,   0.00000,   0.00000,   0.00000,
              0.00000,   0.00000,   0.00000,   0.00000,   0.00000,
WMAX= 285.000,
TIT= 3200.00,
JCB= 5,
JN1= 9,
JN2= 0,
JCAB(1)= 0, 0, 0, 0, 0,
TITLE=E1..      &END
Regenerative Turboshaft Engine - Variable Exhaust Nozzle
```

```

*****
*      The tables were removed - see sample problem 1 for the      *
*      complete table data listing                               *
*****
*****
```

#### 1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

CONFIGURATION DATA			12 STATIONS		20 COMPONENTS	
COMPONENT NUMBER	NKIND TYPE	COMPONENT NUMBER	UPSTREAM STATIONS	DOWNSTREAM STATIONS	UPSTREAM STATIONS	DOWNSTREAM STATIONS
1	1	INLET	1	0	2	0
2	4	COMPRESR	2	0	3	0
3	2	DUCT B	3	0	4	12
4	6	HEAT EXC	4	8	5	9
5	2	DUCT B	5	0	6	0
6	5	TURBINE	6	0	7	0
7	2	DUCT B	7	12	8	0
8	5	TURBINE	9	0	10	0
9	9	NOZZLE	10	0	11	0
10	11	SHAFT	2	6	0	0
11	11	SHAFT	8	12	0	0
12	10	LOAD	0	0	0	0
13	12	CONTROL	10	0	8	0
14	12	CONTROL	9	0	6	0
15	12	CONTROL	4	0	4	0
16	12	CONTROL	6	0	2	0
17	12	CONTROL	2	0	1	0
18	12	CONTROL	10	0	10	0
19	12	CONTROL	11	0	12	0
20	12	CONTROL	0	0	1	0

CONTROL INFORMATION

```

13 VARY CDAT 1 OF COMPONENT 8 SO THAT STATP 8 OF FLOW STATION 10 EQUALS 0.00000E+00
14 VARY CDAT 1 OF COMPONENT 6 SO THAT STATP 8 OF FLOW STATION 9 EQUALS 0.00000E+00
15 VARY CDAT 3 OF COMPONENT 4 SO THAT DATOUT 8 OF COMPONENT 4 EQUALS 0.00000E+00
16 VARY CDAT 1 OF COMPONENT 2 SO THAT STATP 8 OF FLOW STATION 6 EQUALS 0.00000E+00
17 VARY CDAT 1 OF COMPONENT 1 SO THAT STATP 8 OF FLOW STATION 2 EQUALS 0.00000E+00
20 VARY CDAT 1 OF COMPONENT 1 SO THAT NET JET THRUST (LBS) EQUALS 0.20000E+05
18 VARY CDAT 1 OF COMPONENT 10 SO THAT DATOUT 8 OF COMPONENT 10 EQUALS 0.00000E+00
19 VARY CDAT 1 OF COMPONENT 12 SO THAT DATOUT 8 OF COMPONENT 11 EQUALS 0.00000E+00

```

1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

DESIGN POINT MODE

CDAT( 1,1-8 )	0.26742E+03	0.00000E+00	0.14696E+02	0.00000E+00	0.00000E+00	0.11000E+02	0.10000E+03	0.10000E+01
CDAT( 1,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 2,1-8 )	0.20000E+01	0.00000E+00	0.10000E+01	0.70100E+03	0.52945E+01	0.70200E+03	0.10000E+01	0.70300E+03
CDAT( 2,9-15)	0.82090E+00	0.00000E+00	0.00000E+00	0.87000E+00	0.12000E+02	0.10000E+01	0.00000E+00	
CDAT( 3,1-8 )	0.00000E+00	0.00000E+00	0.17148E-04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 3,9-15)	0.50000E-01	0.00000E+00						
CDAT( 4,1-8 )	0.50000E-01	0.50000E-01	0.15000E+04	0.90000E+00	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 4,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 5,1-8 )	0.00000E+00	0.00000E+00	0.66219E-05	0.32000E+04	0.95000E+00	0.18500E+05	0.00000E+00	0.00000E+00
CDAT( 5,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 6,1-8 )	0.30000E+01	0.00000E+00	0.40260E-02	0.12100E+03	0.26400E+01	0.12200E+03	0.10200E+01	0.65446E+00
CDAT( 6,9-15)	0.00000E+00	0.63000E+02	0.92000E+00	0.10000E+03	0.10000E+01	0.00000E+00	0.00000E+00	
CDAT( 7,1-8 )	0.00000E+00	0.00000E+00	0.42854E-06	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.10000E+01
CDAT( 7,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
CDAT( 8,1-8 )	0.30000E+01	0.00000E+00	0.58252E-02	0.12100E+03	0.47606E+01	0.12200E+03	0.10200E+01	0.34107E-02
CDAT( 8,9-15)	0.00000E+00	0.63000E+02	0.92000E+00	0.10000E+03	0.10000E+01	0.00000E+00	0.00000E+00	
CDAT( 9,1-8 )	0.36004E+03	0.98000E+00	0.00000E+00	0.00000E+00	0.98000E+00	0.00000E+00	0.10000E+01	0.00000E+00
CDAT( 9,9-15)	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(10,1-8 )	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT(10,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(11,1-8 )	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00
CDAT(11,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(12,1-8 )	-0.25000E+03	0.00000E+00						
CDAT(12,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(13,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(13,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(14,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(14,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(15,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.30000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(15,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(16,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(16,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(17,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(17,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(18,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(18,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(19,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(19,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	
CDAT(20,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.20000E+05	0.21000E+02	0.00000E+00	0.00000E+00
CDAT(20,9-15)	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	

1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW	TOTAL PRESSURE	TOTAL TEMPERATURE	FUEL/AIR RATIO	REFERRED FLOW	MACH NUMBER	STATIC PRESSURE	INTERFACE RELATIVE FLOW ERROR	STATP1 STATP2	STATP3 STATP4	STATP5 STATP6	STATP7 STATP8
1	0.26742E+03	0.14696E+02	0.51867E+03	0.00000E+00	0.26742E+03	0.00000E+00	0.00000E+00	0.00000E+00	0.13823E+02	0.51867E+03	0.28431E+03	0.00000E+00
2	0.26742E+03	0.16587E+03	0.11218E+04	0.00000E+00	0.34844E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.15758E+03	0.11218E+04	0.34844E+02	0.00000E+00
3	0.26742E+03	0.16587E+03	0.11218E+04	0.00000E+00	0.56072E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.14970E+03	0.26218E+04	0.00000E+00	0.00000E+00
4	0.25405E+03	0.16587E+03	0.11218E+04	0.00000E+00	0.56072E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.14970E+03	0.26218E+04	0.00000E+00	0.00000E+00
5	0.25405E+03	0.16587E+03	0.11218E+04	0.00000E+00	0.56072E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.14970E+03	0.26218E+04	0.00000E+00	0.00000E+00

6	0.25679E+03	0.14221E+03	0.32000E+04	0.10807E-01	0.65912E+02	0.00000E+00	0.00000E+00	0.00000E+00
7	0.25679E+03	0.61594E+02	0.26850E+04	0.10807E-01	0.13940E+03	0.00000E+00	0.00000E+00	0.00000E+00
8	0.27016E+03	0.60362E+02	0.26131E+04	0.10267E-01	0.14764E+03	0.00000E+00	0.00000E+00	0.00000E+00
9	0.27016E+03	0.57344E+02	0.15285E+04	0.10267E-01	0.11886E+03	0.00000E+00	0.00000E+00	0.00000E+00
10	0.27016E+03	0.56955E+02	0.15261E+04	0.10267E-01	0.11957E+03	0.10000E+01	0.30527E+02	0.00000E+00
11	0.27016E+03	0.56955E+02	0.15261E+04	0.10267E-01	0.11957E+03	0.98000E+00	0.14696E+02	0.00000E+00
12	0.13371E+02	0.00000E+00	0.11218E+04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

#### COMPONENT OUTPUT DATA

COMPONENT NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1	INLET	0.00000E+00	0.00000E+00	0.00000E+00	0.10000E+01	0.10000E+01	0.00000E+00	0.94058E+00	0.10000E+01	0.00000E+00
2	COMPRESR	-0.55828E+05	0.10000E+01	0.00000E+00	0.20000E+01	0.10000E+01	0.10000E+01	0.52945E+01	0.87000E+00	0.12000E+02
3	DUCT B	0.00000E+00	0.50000E-01	0.00000E+00						
4	HEAT EXC	0.50000E-01	0.50000E-01	0.00000E+00	0.90000E+00	0.10000E+01	0.13422E+04	0.90000E+00	0.11759E+00	0.00000E+00
5	DUCT B	0.00000E+00	0.50000E-01	0.00000E+00	0.10807E-01	0.00000E+00	0.98842E+04	0.00000E+00	0.18500E+05	0.95000E+00
6	TURBINE	0.55828E+05	0.10000E+01	0.63000E+02	0.30000E+01	0.32000E+04	0.10000E+03	0.26400E+01	0.92000E+00	0.23089E+01
7	DUCT B	0.00000E+00	0.20000E-01	0.00000E+00						
8	TURBINE	0.25000E+03	0.10000E+01	0.63000E+02	0.30000E+01	0.15285E+04	0.10000E+03	0.47606E+01	0.92000E+00	0.10068E+01
9	NOZZLE	0.20000E+05	0.17030E+04	0.18657E+01	0.17378E+04	0.36004E+03	0.98000E+00	0.98000E+00	0.00000E+00	0.38756E+01
10	SHAFT	0.00000E+00	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
11	SHAFT	0.00000E+00	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
12	LOAD	-0.25000E+03	0.10000E+01	0.00000E+00						

#### PERFORMANCE OUTPUTS

(1) NET JET THRUST (LBS)	20000.00	(2) NET BRAKE SHP	0.00	(3) AIRFLOW (LB/SEC)	267.42
(4) TSFC (LB/HR/LB)	0.4942	(5) BSFC (LB/HR/HP)	0.0000	(6) FUEL FLOW (LB/HR)	9884.21
(7) NET THRUST/AIRFLOW	74.79	(8) NET BSHP/AIRFLOW	0.00	(9) INLET DRAG (LBS)	0.00

5 ITERATIONS 14 PASSES

1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

NAMELIST INPUT CARDS FOR NEXT SOLUTION  
 &D  
 IPRINT=0,  
 IDESN=0,  
 FIGSET=0.,  
 CDAT( 1,13)= 0.00000, 0.00000, 0.00000, 1.00000, 0.00000,  
               8.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
               0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
 CDAT( 1,20)= 0.00000, 0.00000, 0.00000, 1.00000, 20000.00000,  
               21.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
               0.00000, 0.00000, 0.00000, 0.00000, 0.00000,

WMAX= 285.000,

TIT= 3200.00,

JCB= 5,

JN1= 9,

JN2= 0,

Jcab(1)= 0, 0, 0, 0, 0,

PUNCH0=0.,

ALT= 0.00,

NM= 1,

XMA(1)= 0.000,

NP=1,

TDEL(1)= 0.000,

TITLE=1., &END

Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.000	20222.	0.	12517.	0.619	285.1	0.000	3200.	0.	0.000	0.	1536.	3.91	361.	0.941	2	1708.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.000,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,

TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.000	20222.		0. 12517.	0.619	285.1	0.000	3200.	0.	0.000	0.	1536.	3.91	361.	0.941	0	1708.
0.	0.000	18690.		0. 11391.	0.609	271.8	0.000	3100.	0.	0.000	0.	1494.	3.68	359.	0.941	9	1685.
0.	0.000	17318.		0. 10405.	0.601	259.8	0.000	3000.	0.	0.000	0.	1452.	3.48	358.	0.941	4	1662.
0.	0.000	15988.		0. 9483.	0.593	248.1	0.000	2900.	0.	0.000	0.	1411.	3.28	356.	0.941	3	1639.
0.	0.000	14704.		0. 8619.	0.586	236.6	0.000	2800.	0.	0.000	0.	1370.	3.09	355.	0.941	4	1616.
0.	0.000	13449.		0. 7800.	0.580	225.0	0.000	2700.	0.	0.000	0.	1329.	2.91	354.	0.941	3	1592.
0.	0.000	12208.		0. 7018.	0.575	213.3	0.000	2600.	0.	0.000	0.	1288.	2.72	352.	0.941	2	1567.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.200,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.200	19173.		0. 12910.	0.673	281.8	0.000	3200.	0.	0.000	0.	1538.	4.04	361.	0.960	4	1709.
0.	0.200	17735.		0. 11788.	0.665	269.2	0.000	3100.	0.	0.000	0.	1496.	3.82	359.	0.960	9	1686.
0.	0.200	16388.		0. 10769.	0.657	257.4	0.000	3000.	0.	0.000	0.	1455.	3.61	358.	0.960	4	1664.
0.	0.200	15093.		0. 9817.	0.650	245.8	0.000	2900.	0.	0.000	0.	1414.	3.40	356.	0.960	5	1641.
0.	0.200	13840.		0. 8921.	0.645	234.4	0.000	2800.	0.	0.000	0.	1373.	3.21	355.	0.960	3	1617.
0.	0.200	12613.		0. 8072.	0.640	222.9	0.000	2700.	0.	0.000	0.	1332.	3.01	354.	0.960	3	1593.
0.	0.200	11397.		0. 7260.	0.637	211.2	0.000	2600.	0.	0.000	0.	1291.	2.82	352.	0.960	3	1569.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.400,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.400	18358.		0. 13459.	0.733	273.7	0.000	3200.	0.	0.000	0.	1544.	4.24	361.	0.964	2	1712.
0.	0.400	16962.		0. 12317.	0.726	261.9	0.000	3100.	0.	0.000	0.	1503.	4.01	359.	0.964	5	1690.
0.	0.400	15647.		0. 11259.	0.720	250.4	0.000	3000.	0.	0.000	0.	1462.	3.79	358.	0.964	4	1668.
0.	0.400	14373.		0. 10263.	0.714	239.1	0.000	2900.	0.	0.000	0.	1421.	3.58	357.	0.964	3	1645.
0.	0.400	13135.		0. 9323.	0.710	228.0	0.000	2800.	0.	0.000	0.	1380.	3.37	355.	0.964	3	1622.
0.	0.400	11917.		0. 8429.	0.707	216.6	0.000	2700.	0.	0.000	0.	1339.	3.16	354.	0.964	3	1598.
0.	0.400	10693.		0. 7565.	0.707	204.8	0.000	2600.	0.	0.000	0.	1298.	2.95	352.	0.964	3	1573.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.600,  
 NP=7,  
 TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
 TIT= 3200.00,  
 TITLE=1., &  
 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.600	17989.		0. 14350.	0.798	261.7	0.000	3200.	0.	0.000	0.	1555.	4.55	361.	0.964	2	1718.
0.	0.600	16613.		0. 13149.	0.791	250.6	0.000	3100.	0.	0.000	0.	1514.	4.31	360.	0.964	3	1696.
0.	0.600	15285.		0. 12019.	0.786	239.6	0.000	3000.	0.	0.000	0.	1474.	4.07	358.	0.964	4	1674.
0.	0.600	13998.		0. 10951.	0.782	228.8	0.000	2900.	0.	0.000	0.	1433.	3.84	357.	0.964	4	1652.
0.	0.600	12737.		0. 9935.	0.780	217.9	0.000	2800.	0.	0.000	0.	1392.	3.62	356.	0.964	2	1629.
0.	0.600	11478.		0. 8957.	0.780	206.5	0.000	2700.	0.	0.000	0.	1352.	3.39	354.	0.964	3	1605.

0. 0.600 10220. 0. 8018. 0.784 194.8 0.000 2600. 0. 0.000 0. 1311. 3.16 353. 0.964 3 1581.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 0.00,  
NM= 1,  
XMA(1)= 0.800,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.800	18081.	0.	15674.	0.867	246.8	0.000	3200.	0.	0.000	0.	1571.	5.02	362.	0.963	3	1727.	
0.	0.800	16669.	0.	14363.	0.862	236.3	0.000	3100.	0.	0.000	0.	1531.	4.75	360.	0.963	3	1705.	
0.	0.800	15294.	0.	13119.	0.858	225.9	0.000	3000.	0.	0.000	0.	1490.	4.49	359.	0.963	4	1683.	
0.	0.800	13949.	0.	11934.	0.856	215.4	0.000	2900.	0.	0.000	0.	1450.	4.24	358.	0.963	3	1661.	
0.	0.800	12600.	0.	10787.	0.856	204.4	0.000	2800.	0.	0.000	0.	1409.	3.97	356.	0.963	3	1638.	
0.	0.800	11264.	0.	9690.	0.860	193.2	0.000	2700.	0.	0.000	0.	1369.	3.71	355.	0.963	3	1615.	
0.	0.800	9982.	0.	8665.	0.868	182.0	0.000	2600.	0.	0.000	0.	1329.	3.46	354.	0.963	3	1592.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 0.00,  
NM= 1,  
XMA(1)= 1.000,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine - Variable Exhaust Nozzle

1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	1.000	18516.	0.	17459.	0.943	230.0	0.000	3200.	0.	0.000	0.	1592.	5.66	362.	0.963	4	1738.	
0.	1.000	17018.	0.	15980.	0.939	220.1	0.000	3100.	0.	0.000	0.	1552.	5.36	361.	0.963	2	1716.	
0.	1.000	15535.	0.	14556.	0.937	209.9	0.000	3000.	0.	0.000	0.	1512.	5.05	360.	0.963	3	1695.	
0.	1.000	14056.	0.	13181.	0.938	199.2	0.000	2900.	0.	0.000	0.	1472.	4.75	358.	0.963	2	1673.	
0.	1.000	12611.	0.	11877.	0.942	188.6	0.000	2800.	0.	0.000	0.	1432.	4.44	357.	0.963	3	1651.	
0.	1.000	11239.	0.	10666.	0.949	178.2	0.000	2700.	0.	0.000	0.	1392.	4.15	356.	0.963	2	1628.	
0.	1.000	9942.	0.	9546.	0.960	168.1	0.000	2600.	0.	0.000	0.	1352.	3.87	354.	0.963	3	1605.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 10000.00,  
NM= 1,  
XMA(1)= 1.200,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	1.200	15481.	0.	15380.	0.993	230.2	0.000	3200.	0.	0.000	0.	1592.	7.25	362.	0.962	3	1738.	
10000.	1.200	14245.	0.	14079.	0.988	220.2	0.000	3100.	0.	0.000	0.	1552.	6.86	361.	0.962	4	1716.	
10000.	1.200	13013.	0.	12821.	0.985	209.9	0.000	3000.	0.	0.000	0.	1512.	6.47	360.	0.962	2	1695.	
10000.	1.200	11795.	0.	11612.	0.984	199.3	0.000	2900.	0.	0.000	0.	1471.	6.08	358.	0.962	2	1673.	
10000.	1.200	10608.	0.	10466.	0.987	188.7	0.000	2800.	0.	0.000	0.	1431.	5.69	357.	0.962	2	1651.	
10000.	1.200	9475.	0.	9396.	0.992	178.2	0.000	2700.	0.	0.000	0.	1392.	5.31	356.	0.962	2	1628.	
10000.	1.200	8409.	0.	8410.	1.000	168.2	0.000	2600.	0.	0.000	0.	1352.	4.95	354.	0.962	3	1605.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 10000.00,  
NM= 1,  
XMA(1)= 1.000,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &

Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	1.000	14920.	0.	13613.	0.912	249.4	0.000	3200.	0.	0.000	0.	1568.	6.33	362.	0.963	4	1725.
10000.	1.000	13764.	0.	12475.	0.906	238.9	0.000	3100.	0.	0.000	0.	1528.	5.99	360.	0.963	3	1704.
10000.	1.000	12642.	0.	11397.	0.902	228.3	0.000	3000.	0.	0.000	0.	1487.	5.66	359.	0.963	3	1682.
10000.	1.000	11548.	0.	10370.	0.898	217.8	0.000	2900.	0.	0.000	0.	1447.	5.34	358.	0.963	2	1659.
10000.	1.000	10461.	0.	9382.	0.897	206.9	0.000	2800.	0.	0.000	0.	1406.	5.02	356.	0.963	3	1637.
10000.	1.000	9382.	0.	8433.	0.899	195.5	0.000	2700.	0.	0.000	0.	1366.	4.69	355.	0.963	2	1613.
10000.	1.000	8339.	0.	7540.	0.904	184.3	0.000	2600.	0.	0.000	0.	1325.	4.36	353.	0.963	3	1590.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 10000.00,
NM= 1,
XMA(1)= 0.800,
NP=7,
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine - Variable Exhaust Nozzle
```

1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.800	14528.	0.	12229.	0.842	267.9	0.000	3200.	0.	0.000	0.	1549.	5.61	361.	0.963	4	1715.
10000.	0.800	13411.	0.	11198.	0.835	256.5	0.000	3100.	0.	0.000	0.	1508.	5.31	360.	0.963	3	1693.
10000.	0.800	12354.	0.	10239.	0.829	245.3	0.000	3000.	0.	0.000	0.	1467.	5.03	358.	0.963	3	1671.
10000.	0.800	11327.	0.	9332.	0.824	234.2	0.000	2900.	0.	0.000	0.	1426.	4.74	357.	0.963	3	1648.
10000.	0.800	10327.	0.	8474.	0.821	223.2	0.000	2800.	0.	0.000	0.	1386.	4.47	355.	0.963	6	1625.
10000.	0.800	9342.	0.	7652.	0.819	211.9	0.000	2700.	0.	0.000	0.	1345.	4.19	354.	0.963	3	1601.
10000.	0.800	8352.	0.	6857.	0.821	200.1	0.000	2600.	0.	0.000	0.	1304.	3.91	353.	0.963	3	1577.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 10000.00,
NM= 1,
XMA(1)= 0.600,
NP=7,
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine - Variable Exhaust Nozzle
```

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.600	14507.	0.	11297.	0.779	285.8	0.000	3200.	0.	0.000	0.	1536.	5.12	361.	0.964	6	1708.
10000.	0.600	13354.	0.	10273.	0.769	272.4	0.000	3100.	0.	0.000	0.	1494.	4.83	359.	0.964	12	1685.
10000.	0.600	12307.	0.	9382.	0.762	260.3	0.000	3000.	0.	0.000	0.	1452.	4.56	358.	0.964	4	1662.
10000.	0.600	11300.	0.	8550.	0.757	248.6	0.000	2900.	0.	0.000	0.	1411.	4.30	356.	0.964	4	1639.
10000.	0.600	10337.	0.	7771.	0.752	237.0	0.000	2800.	0.	0.000	0.	1370.	4.05	355.	0.964	3	1616.
10000.	0.600	9393.	0.	7032.	0.749	225.4	0.000	2700.	0.	0.000	0.	1329.	3.81	354.	0.964	2	1591.
10000.	0.600	8476.	0.	6329.	0.747	213.7	0.000	2600.	0.	0.000	0.	1288.	3.57	352.	0.964	2	1567.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 10000.00,
NM= 1,
XMA(1)= 0.400,
NP=7,
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine - Variable Exhaust Nozzle
```

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.400	14888.	0.	11096.	0.745	298.5	0.000	3200.	0.	0.000	0.	1547.	4.79	361.	0.964	10	1714.
10000.	0.400	13681.	0.	9711.	0.710	286.2	0.000	3100.	0.	0.000	0.	1484.	4.52	359.	0.964	15	1680.
10000.	0.400	12553.	0.	8798.	0.701	272.3	0.000	3000.	0.	0.000	0.	1441.	4.24	357.	0.964	8	1656.
10000.	0.400	11547.	0.	8012.	0.694	259.9	0.000	2900.	0.	0.000	0.	1400.	4.00	356.	0.964	5	1633.
10000.	0.400	10590.	0.	7283.	0.688	247.8	0.000	2800.	0.	0.000	0.	1358.	3.77	355.	0.964	4	1609.
10000.	0.400	9660.	0.	6595.	0.683	235.8	0.000	2700.	0.	0.000	0.	1317.	3.54	353.	0.964	4	1585.
10000.	0.400	8756.	0.	5945.	0.679	223.8	0.000	2600.	0.	0.000	0.	1276.	3.32	352.	0.964	4	1560.

## NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 10000.00,  
NM= 1,  
XMA(1)= 0.200,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine - Variable Exhaust Nozzle

## 1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.200	15121.	0.	10586.	0.700	300.8	0.000	3200.	0.	0.000	0.	1550.	4.49	361.	0.960	5	1715.	
10000.	0.200	14527.	0.	9746.	0.671	297.2	0.000	3100.	0.	0.000	0.	1495.	4.37	359.	0.960	6	1685.	
10000.	0.200	13111.	0.	8436.	0.643	280.3	0.000	3000.	0.	0.000	0.	1435.	4.05	357.	0.960	16	1653.	
10000.	0.200	12073.	0.	7668.	0.635	267.2	0.000	2900.	0.	0.000	0.	1393.	3.81	356.	0.960	4	1629.	
10000.	0.200	11096.	0.	6967.	0.628	254.7	0.000	2800.	0.	0.000	0.	1352.	3.59	354.	0.960	5	1605.	
10000.	0.200	10154.	0.	6309.	0.621	242.3	0.000	2700.	0.	0.000	0.	1310.	3.37	353.	0.960	3	1580.	
10000.	0.200	9239.	0.	5691.	0.616	230.1	0.000	2600.	0.	0.000	0.	1269.	3.16	351.	0.960	4	1556.	

## NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 10000.00,  
NM= 1,  
XMA(1)= 0.000,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
10000.	0.000	15842.	0.	10484.	0.662	302.4	0.000	3200.	0.	0.000	0.	1562.	4.33	361.	0.941	48	1721.	
10000.	0.000	15123.	0.	9411.	0.622	298.0	0.000	3100.	0.	0.000	0.	1495.	4.19	359.	0.941	28	1686.	
10000.	0.000	13814.	0.	8169.	0.591	283.3	0.000	3000.	0.	0.000	0.	1433.	3.91	357.	0.941	14	1652.	
10000.	0.000	12729.	0.	7410.	0.582	269.7	0.000	2900.	0.	0.000	0.	1391.	3.68	356.	0.941	6	1628.	
10000.	0.000	11731.	0.	6732.	0.574	257.1	0.000	2800.	0.	0.000	0.	1349.	3.46	354.	0.941	4	1604.	
10000.	0.000	10765.	0.	6096.	0.566	244.6	0.000	2700.	0.	0.000	0.	1308.	3.26	353.	0.941	3	1579.	
10000.	0.000	9826.	0.	5498.	0.560	232.3	0.000	2600.	0.	0.000	0.	1267.	3.05	351.	0.941	3	1554.	

## NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 20000.00,  
NM= 1,  
XMA(1)= 1.200,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
20000.	1.200	12261.	0.	11764.	0.960	251.1	0.000	3200.	0.	0.000	0.	1567.	8.17	361.	0.962	27	1724.	
20000.	1.200	11312.	0.	10781.	0.953	240.4	0.000	3100.	0.	0.000	0.	1526.	7.74	360.	0.962	3	1703.	
20000.	1.200	10398.	0.	9850.	0.947	229.8	0.000	3000.	0.	0.000	0.	1485.	7.31	359.	0.962	3	1681.	
20000.	1.200	9510.	0.	8966.	0.943	219.3	0.000	2900.	0.	0.000	0.	1445.	6.90	357.	0.962	3	1658.	
20000.	1.200	8631.	0.	8115.	0.940	208.4	0.000	2800.	0.	0.000	0.	1404.	6.48	356.	0.962	4	1636.	
20000.	1.200	7754.	0.	7291.	0.940	197.0	0.000	2700.	0.	0.000	0.	1364.	6.05	355.	0.962	2	1612.	
20000.	1.200	6915.	0.	6524.	0.944	185.7	0.000	2600.	0.	0.000	0.	1323.	5.64	353.	0.962	3	1588.	

## NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 20000.00,  
NM= 1,  
XMA(1)= 1.000,  
NP=7,  
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Regenerative Turboshaft Engine - Variable Exhaust Nozzle

1 Regenerative Turboshaft Engine - Variable Exhaust Nozzle

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
20000.	1.000	11778.	0.	10427.	0.885	272.6	0.000	3200.	0.	0.000	0. 1545.	7.14	361.	0.963	4	1713.		
20000.	1.000	10876.	0.	9545.	0.878	260.9	0.000	3100.	0.	0.000	0. 1504.	6.75	359.	0.963	5	1691.		
20000.	1.000	10021.	0.	8724.	0.871	249.5	0.000	3000.	0.	0.000	0. 1463.	6.39	358.	0.963	3	1668.		
20000.	1.000	9194.	0.	7955.	0.865	238.2	0.000	2900.	0.	0.000	0. 1422.	6.03	357.	0.963	2	1645.		
20000.	1.000	8395.	0.	7225.	0.861	227.1	0.000	2800.	0.	0.000	0. 1381.	5.68	355.	0.963	2	1622.		
20000.	1.000	7617.	0.	6530.	0.857	215.8	0.000	2700.	0.	0.000	0. 1340.	5.33	354.	0.963	3	1598.		
20000.	1.000	6834.	0.	5856.	0.857	203.9	0.000	2600.	0.	0.000	0. 1299.	4.98	352.	0.963	2	1574.		

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 30000.00,
NM= 1,
XMA(1)= 1.200,
NP=7,
TDEL(1)= 100.000, 100.000, 100.000, 100.000, 100.000, 100.000,
TIT= 3200.00,
TITLE=1., &
Regenerative Turboshaft Engine - Variable Exhaust Nozzle
```

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
30000.	1.200	9487.	0.	8824.	0.930	276.6	0.000	3200.	0.	0.000	0. 1542.	9.31	361.	0.962	5	1711.		
30000.	1.200	8761.	0.	8073.	0.921	264.6	0.000	3100.	0.	0.000	0. 1500.	8.81	359.	0.962	4	1689.		
30000.	1.200	8070.	0.	7376.	0.914	253.0	0.000	3000.	0.	0.000	0. 1459.	8.33	358.	0.962	3	1666.		
30000.	1.200	7413.	0.	6725.	0.907	241.6	0.000	2900.	0.	0.000	0. 1418.	7.86	357.	0.962	3	1643.		
30000.	1.200	6777.	0.	6111.	0.902	230.3	0.000	2800.	0.	0.000	0. 1377.	7.41	355.	0.962	3	1620.		
30000.	1.200	6156.	0.	5525.	0.898	218.9	0.000	2700.	0.	0.000	0. 1336.	6.95	354.	0.962	2	1596.		
30000.	1.200	5544.	0.	4964.	0.895	207.2	0.000	2600.	0.	0.000	0. 1296.	6.50	352.	0.962	3	1572.		

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D ENDRUN=1 &END
```

### Sample Problem 3—Modifying an Existing Configuration

#### *QDATGEN Terminal Session*

The following is a sample terminal session used to generate QNEP input for a dual-rotor turbojet configuration (fig. C3). Therefore option 4, “Dual-rotor turbojet with or without afterburning,” is selected. In this example the design point net thrust is set at 10 000 lb at Mach 3. As in the preceding example the nozzle area is allowed to vary. In order to achieve the design point net thrust of 10 000 lb a control must be added in the design point NAMELIST input. Because the nozzle area is allowed to vary, the control on the nozzle interface relative flow error included in the default configuration must be deactivated for the off-design point cases. To account for the nozzle interface relative flow error, the nozzle switch is set to float the nozzle area to accept whatever mass flow the turbine is passing to it. Off-design point input data are generated for a constant dynamic pressure path of 700 psf for afterburner both on and off. The maximum allowable Mach number is 3. The “-O” command line option is used to override the default output file name. The following,

“QDATGEN -O CASE3.INP”

is entered to start.

QDATGEN; PC version: 1.21

This program allows the interactive generation of an input file written in namelist format, for use in QNEP, a special version of NEPCOMP II. The user should already be familiar with QNEP and should have a schematic diagram of the engine to be modeled on hand.

The QDATGEN output file will default to "TAPES" ....  
the default can be changed from the command line by entering  
QDATGEN -O [filename].

Press Enter to Continue.

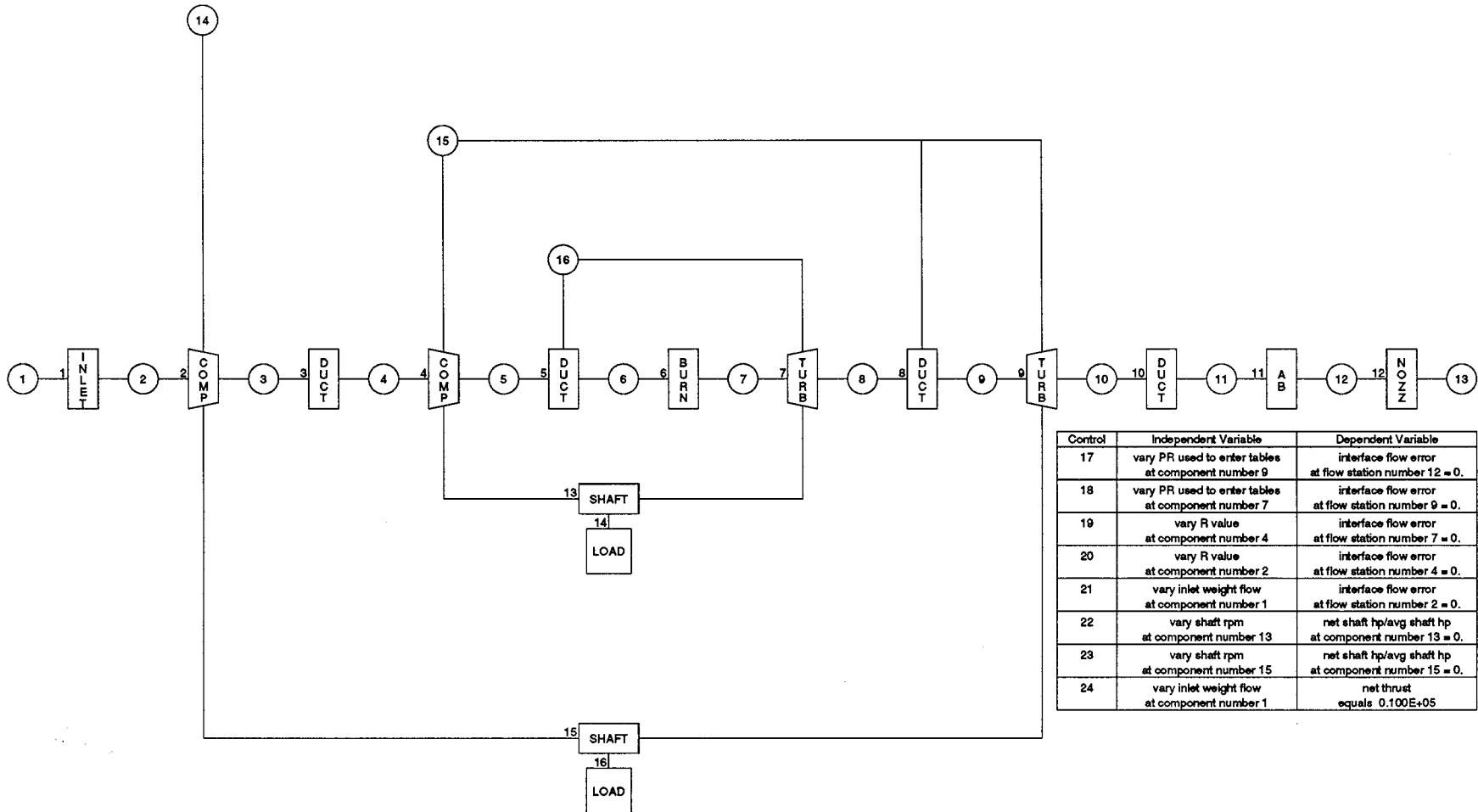


Figure C3. Dual rotor turbojet configuration for sample problem 3.

```

Select engine to be modeled...
-1 = Modify an existing design point namelist input.
 0 = User specified engine.
 1 = Dual-rotor turbofan with or without afterburning.
    Bypass airflow passes through the lp rotor.
 2 = Dual-rotor turbofan with or without afterburning.
    Bypass airflow passes through a lp fan only.
    This engine requires 3 compressor components.
 3 = Dual-rotor turbofan with or without afterburning.
    Bypass airflow passes through a lp fan to a fan nozzle.
    This engine requires 3 compressor components.
 4 = Dual-rotor turbojet with or without afterburning.
 5 = Single-rotor turbojet with or without afterburning.
 6 = Dual-rotor turbofan with or without afterburning.
    Bypass airflow passes through a lp fan to a fan nozzle.
    This engine requires 2 compressor components.
 7 = Ramjet
>>4

Input data for the inlet:
A - Mass flow = 100.000
B - Altitude = 0.000000
C - Mach = 0.000000
D - TO = 518.670
E - PO = 14.6960
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>BC
Enter the altitude (ft).
>>60000
Enter the Mach number.
>>3
Input data for the compressor designated as component number 2.
A - Design point efficiency = 0.870000
B - Design point pressure ratio = 2.50000
C - Design point referred speed = 1.000000
D - Bleed flow = 0.100000E-01
E - Bleed horsepower loss = 0.000000
F - R value = 1.80000
G - Value of third argument = 10.0000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>ABCDG
Enter the design point adiabatic efficiency.
>>.84
Enter the design point pressure ratio.
>>3
Enter the design point referred speed.
>>.7
Enter the bleed flow (fraction of inlet flow).
>>0
Enter the value of the third argument.
>>90
Input data for the duct designated by component number 3.
A - Delta-p/p = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Input data for the compressor designated as component number 4.
A - Design point efficiency = 0.870000
B - Design point pressure ratio = 3.60000
C - Design point referred speed = 1.000000
D - Bleed flow = 0.100000E-01
E - Bleed horsepower loss = 0.000000
F - R value = 2.00000
G - Value of third argument = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>ABCDGF
Enter the design point adiabatic efficiency.
>>.84
Enter the design point pressure ratio.
>>5
Enter the design point referred speed.
>>.7
Enter the bleed flow (fraction of inlet flow).

```

```

>>.01
Enter the R-value used to enter tables.
>>1.8
Enter the value of the third argument.
>>90
Input data for the duct designated by component number 5.
A - Delta-p/p = 0.000000
B - Exit bleed flow = 0.100000E-01
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>B
Enter the exit bleed flow (fraction of total exit).
>>.03
Input data for the burner designated by component number 6.
A - Delta-p/p = 0.400000E-01
B - Outlet temperature = 2500.00
C - Fuel heating value = 18400.0
D - Burner efficiency = 0.990000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>ABC
Enter delta-p/p.
>>0
Enter the burner outlet temperature (R).
>>3000
Enter the fuel heating value (btu/lbm).
>>18500
Input data for the turbine designated as component number 7.
A - Design point efficiency = 0.920000
B - Design point referred speed = 100.000
C - Total bleed flow = 1.000000
D - Bleed entering front = 0.600000
E - Value of third argument = 63.0000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>AD
Enter the design point adiabatic efficiency.
>>.90
Enter the bleed flow entering the front (fraction of total).
>>.5
Input data for the duct designated by component number 8.
A - Delta-p/p = 0.000000
B - Entering bleed flow = 0.800000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>B
Enter the bleed flow entering (fraction of available).
>>0
Input data for the turbine designated as component number 9.
A - Design point efficiency = 0.920000
B - Design point referred speed = 100.000
C - Total bleed flow = 0.200000
D - Bleed entering front = 0.500000
E - Value of third argument = 63.0000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>AC
Enter the design point adiabatic efficiency.
>>.9
Enter the bleed flow (fraction of available).
>>1
Input data for the duct designated by component number 10.
A - Delta-p/p = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Input data for the afterburner designated by component number 11.
A - Delta-p/p = 0.400000E-01
B - Efficiency (0 for duct) = 0.000000
C - Outlet temperature = 0.000000
D - Fuel heating value = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Input data for the nozzle designated by component number 12.
A - Type: C=0, C-D=1; Type = 1.000000
B - Fixed=0, Variable=1; switch = 1.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Input data for the shaft designated by component number 13.

```

```

A - Shaft RPM =      1.00000
B - Gear ratio =     1.00000
C - Mechanical efficiency = 1.00000
D - Load horsepower = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Input data for the load designated by component number 14.
A - Load horse power = 0.000000
B - Switch (1 to include HP in overall perf. summery = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Input data for the shaft designated by component number 15.
A - Shaft RPM =      1.00000
B - Gear ratio =     1.00000
C - Mechanical efficiency = 1.00000
D - Load horsepower = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Input data for the load designated by component number 16.
A - Load horse power = 0.000000
B - Switch (1 to include HP in overall perf. summery = 0.000000
Enter letter(s) where changes are desired (no spaces, rtn for no changes).
>>
Enter: 0 to specify geometric altitude or 1 for geopotential.
(Current value=0. Enter rtn for no change)
>>
Enter WMAX (current value = 100.0, enter <rtn> for no change).
>>350

```

TABLE DATA DECK	CURRENT VALUE	DEFAULT
A - Inlet pressure recovery	11.00	11
B - Inlet drag coefficient	0.00	none
C - Referred flow (LP comp.)	701.00	701
D - Efficiency (LP compressor)	702.00	702
E - Pressure ratio (LP comp.)	703.00	703
F - Referred flow (HP comp)	701.00	701
G - Efficiency (HP compressor)	702.00	702
H - Pressure ratio (HP comp.)	703.00	703
I - Referred flow (HP turb.)	121.00	121
J - Efficiency (HP turbine)	122.00	122
K - Referred flow (LP turb.)	121.00	121
L - Efficiency (LP turbine)	122.00	122
M - Afterburner efficiency	0.00	none
N - Nozzle flow coefficient	0.99	none
O - Nozzle drag coefficient	0.00	none
P - Nozzle thrust coefficient	0.99	none
Q - Exit:throat area schedule	0.00	none
Referred flow schedule	111	

```

Enter letter, value to change values (rtn to stop)
>>
Enter the number of controls to be added (MAX=17).
>>1
Enter either the flow station number or the component number where
the control dependent variable is located (or zero).
-Flow station if the control dependent variable is a station
property output.
-Component number if the control dependent variable is a "DATOUT" variable
-Zero if the control dependent variable is a performance property.
>>0
Enter the component number where the control independent variable
is located. Independent variable may only be one of the "CDAT" input
variables.
>>1

```

```

Component number 24 is a Control

Is this control active (Y/N) ?
>>Y
Enter the desired tolerance (DEFAULT=.001).
>>
Enter the minimum value of the independent variable (enter zero for
no limit).
>>

```

```

Enter the maximum value (zero for no limit).
>>
Which CDAT variable is the independent variable for the Inlet
designated by component number 1 for this control variable.
    1 - Inlet weight flow, lbs/sec
    2 - Freestream static temperature, R
    3 - Freestream static pressure, psi
    4 - Inlet drag D/(q*SF)
    5 - Inlet freestream Mach number
    6 - Pressure recovery
    7 - Maximum permitted referred flow
    8 - Scale factor on referred flow
    9 - Altitude as input, ft.
   10 - Freestream fuel:air ratio
   11 - Switch
   12 - Reference area, in*in
   13 - Scale factor on inlet drag
>>1
The dependent variable of control is:
    1 - Net thrust (lbs).
    2 - Brake SHP (hp).
    3 - Air flow (lbs/sec).
    4 - TSFC (lbs/hr/lb).
    5 - BSFS (lbs/hr/hp).
    6 - Fuel flow (lbs/hr).
    7 - Thrust:airflow ratio (lb-sec/lb).
    8 - Net BSHP:airflow ratio (hp-sec/lb).
    9 - Inlet drag (lbs).
>>1
Enter the desired value of the control dependent variable.
>>10000

Are the CDAT inputs correct up to this point (Y/N) ?
>>

Select one: 0 - Off design mode.
            1 - Design mode calculation sequence.
IDESN=1
>>
Select one: 0 - Regular solution print out.
            1 - Extra print diagnostics + regular.
            2 - Full convergence history + regular.
IPRINT=0
>>
Do you want a title card (Y/N) ?
>>Y
Enter title (one line max).
>>Dual-Rotor Turbojet
Select one: 0 - No tabular data.
            1 - Tabular data.
            2 - Print tabular data.
>>1
Enter the altitude (enter -1 to specify free stream static temperature
and pressure).
>>60000
Do you want mach, thrust, and fuel flow in format compatible with
other performance codes (Y/N) ?
>>N
Enter the design burner outlet temperature.
Default is the bot of the design point solution.
>>3000
Do you want to use the default tables for the engine selected (Y/N) ?
>>Y
Enter the number of runs desired.
Note: full data sets are treated as one run and
include any combination of constant dynamic
pressure paths and constant altitude flight
envelopes.
>>4

```

Changes to input data for case - 1

Do you want any changes in the input data (Y/N) ?

Note: controls associated with the design point should be deactivated here.  
(default=NO)

>>N

Note: For a variable area nozzle the control on the nozzle  
interface relative flow error must be deactivated.

Do you want to reconsider (Y/N) ?

(default=NO)

>>Y

Do you want any changes in the input data (Y/N) ?

Note: controls associated with the design point should be deactivated here.  
(default=NO)

>>Y

Component number	Component type	Component number	Component type
1	- Inlet	13	- Shaft
2	- Compressor	14	- Load
3	- Duct, Burner, or A/B	15	- Shaft
4	- Compressor	16	- Load
5	- Duct, Burner, or A/B	17	- Control
6	- Duct, Burner, or A/B	18	- Control
7	- Turbine	19	- Control
8	- Duct, Burner, or A/B	20	- Control
9	- Turbine	21	- Control
10	- Duct, Burner, or A/B	22	- Control
11	- Duct, Burner, or A/B	23	- Control
12	- Nozzle	24	- Control

Enter the number of components requiring changes.

>>2

On one line enter the component numbers where changes are required.

>>17,24

In making changes to controls do you want only to turn them on or off (Y/N)?

>>Y

Component number 17 is a Control

Is this control active (Y/N) ?

>>N

Component number 24 is a Control

Is this control active (Y/N) ?

>>N

Enter options (no spaces between entries)

A - Change altitude  
M - Change mach numbers  
T - Change throttle setting points  
B - Change burner or afterburner inputs  
W - Maximum weight flow  
P - Change print controls  
L - Change title  
Q - Change tables  
N - No further changes  
Z - Change all inputs  
S - Stop

>>AMT

Select one: 0 - Off design mode.

1 - Design mode calculation sequence.

IDESCN=0

>>

Enter the altitude (enter -1 to specify free stream static temperature  
and pressure).

>>40000

Enter the number of mach numbers to be run at the current altitude  
(MAX=16).

>>1

On one line enter the Mach numbers.

>>1.6

Enter the number of throttle setting points to be run at the current altitude (7=MAX).

>>1

Do you want to generate a complete set of data (Y/N) ?

>>Y

Do you want cycle the input to improve QNEP reliability (y/n) ?

>>N

Do you want to generate the data deck for constant dynamic pressure paths (y/n) ?

>>Y

Enter the number of throttle setting points to be run at point (MAX=7).

>>4

Enter the increments between throttle setting points (MAX=6).

>>3\*100

Is this data deck being run non-afterburning (Y/N) ?

>>Y

Enter the maximum turbine inlet temperature (R).  
(or burner outlet temperature)

>>3000

Enter the dynamic pressure.

>>700

Enter the starting mach number.

>>0

Enter the maximum allowable mach number (multiple of increment).

>>3

Enter the increment between Mach numbers.

>>.5

Another dynamic pressure (y/n) ?

>>N

Another full data set (y/n) ?

>>N

Changes to input data for case - 3

Do you want any changes in the input data (Y/N) ?

Note: controls associated with the design point should be deactivated here.  
(default=NO)

>>Y

Component number	Component type	Component number	Component type
1 - Inlet		13 - Shaft	
2 - Compressor		14 - Load	
3 - Duct, Burner, or A/B		15 - Shaft	
4 - Compressor		16 - Load	
5 - Duct, Burner, or A/B		17 - Control	
6 - Duct, Burner, or A/B		18 - Control	
7 - Turbine		19 - Control	
8 - Duct, Burner, or A/B		20 - Control	
9 - Turbine		21 - Control	
10 - Duct, Burner, or A/B		22 - Control	
11 - Duct, Burner, or A/B		23 - Control	
12 - Nozzle		24 - Control	

Enter the number of components requiring changes.

>>1

On one line enter the component numbers where changes are required.

>>11

Component number 11 is a Duct, Burner, or A/B

Enter the delta p/p (.Lt.1) Or table reference number

>>.06

Enter the corrected flow squared coefficient used as an adder to the pressure drop.

>>

Is the component a duct (Y/N) ?

>>N

Enter the burner efficiency or table reference number.

>>.80

```

Enter the design point afterburner mach number used to compute area.
For rayleigh line momentum pressure drop. (Enter zero for no momentum
pressure drop.)
>>
    Enter the burner outlet temperature, R.
>>4000
    Enter the fuel heating value, btu/lbm, or table reference number.
>>18500
    Are the CDAT inputs correct up to this point (Y/N) ?
>>
    Enter options (no spaces between entries)
    A - Change altitude
    M - Change mach numbers
    T - Change throttle setting points
    B - Change burner or afterburner inputs
    W - Maximum weight flow
    P - Change print controls
    L - Change title
    Q - Change tables
    N - No further changes
    Z - Change all inputs
    S - Stop
>>AMTL

```

```

Select one: 0 - Off design mode.
            1 - Design mode calculation sequence.
IDESN=0
>>
    Do you want a title card (Y/N) ?
>>Y
    Enter title (one line max).
>>Dual-Rotor Turbojet... Afterburner On
    Enter the altitude (enter -1 to specify free stream static temperature
    and pressure).
>>40000
    Enter the number of mach numbers to be run at the current altitude
    (MAX=16).
>>1
    On one line enter the Mach numbers.
>>1.6
    Enter the number of throttle setting points to be run at the current
    altitude (7=MAX).
>>1
    Do you want to generate a complete set of data (Y/N) ?
>>Y
    Do you want cycle the input to improve QNEP reliability (y/n) ?
>>N
    Do you want to generate the data deck for constant
    dynamic pressure paths (y/n) ?
>>Y
    Enter the number of throttle setting points to be run at point (MAX=7).
>>4
    Enter the increments between throttle setting points (MAX=6).
>>3*200
    Is this data deck being run non-afterburning (Y/N) ?
>>N
    Enter the maximum afterburner temperature.
>>4000
    Enter the maximum turbine inlet temperature (R).
    (or burner outlet temperature)
>>3000
    Enter the dynamic pressure.
>>700
    Enter the starting mach number.
>>0
    Enter the maximum allowable mach number (multiple of increment).
>>3
    Enter the increment between Mach numbers.
>>.5
    Another dynamic pressure (y/n) ?
>>N

```

```
Another full data set (y/n) ?  
>>N  
  
The input file to QNEP has been written to CASE3.INP.  
There are a total of 15 &D NAMELIST input cases  
including design point cases.
```

### *QNEP Terminal Session*

Once the QNEP input file has been generated, the following modifications are made:

1. Because the design point is chosen at a high Mach number, the nondimensional referred flow schedule is replaced with one that does not vary with Mach number.
2. Again, because of the high design point Mach number, a reasonable value for WMAX has to be determined. In order to do this, the third NAMELIST input (sea level static) is modified by changing the number of throttle setting points to seven and adding three increment values to TDEL.
3. Finally a termination card, "&D ENDRUN=1 &END," is added at the end of the third NAMELIST input.

With these changes complete QNEP is run with the “-M” option set. From the results of this first run, WMAX is selected as 327, where the compressor corrected speed is approximately equal to 1.1. The QNEP input file is again modified by setting WMAX to 327 and removing the termination card after the third NAMELIST input. Because the turbine inlet temperature is substantially larger than the value required to satisfy the maximum referred flow at the lower Mach numbers, the QNEP input file has to be further modified by manually reducing the input TIT for these points. The sample output that follows is the result. The following,

“QNEP -i case3.inp -o case3.dat”

is entered to start.

```
QNEP; PC version: 1.40  
  
Design point complete.....  
  
Done...  
  
Total number of good points = 58  
  
Total Elapsed Time is 14 minutes 47 seconds  
  
Number of points/min = 3.9
```

The QNEP output file begins below. In order to save space the table data, except for the nondimensional referred flow schedule, have been omitted. The other table data are unchanged from the first sample case.

## NAVAL AIR DEVELOPMENT CENTER

NEPII NAVY ENGINE PERFORMANCE COMPUTER CODE  
MODIFIED VERSION 1.00 - IBM PC OR COMPATIBLE

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
IPRINT=0,  
NCOMP=24,  
NOSTAT=16,  
IDESN=1,  
TABLES=1.,  
FIGSET=1.,  
JFIG(1, 1)= 1, 1, 0, 2, 0,  
JFIG(1, 2)= 4, 2, 0, 3,14,  
JFIG(1, 3)= 2, 3, 0, 4, 0,  
JFIG(1, 4)= 4, 4, 0, 5,15,  
JFIG(1, 5)= 2, 5, 0, 6,16,  
JFIG(1, 6)= 2, 6, 0, 7, 0,  
JFIG(1, 7)= 5, 7,16, 8, 0,  
JFIG(1, 8)= 2, 8,15, 9, 0,  
JFIG(1, 9)= 5, 9,15,10, 0,  
JFIG(1,10)= 2,10, 0,11, 0,  
JFIG(1,11)= 2,11, 0,12, 0,  
JFIG(1,12)= 9,12, 0,13, 0,  
JFIG(1,13)=11, 4, 7,14, 0,  
JFIG(1,14)=10, 0, 0, 0, 0,  
JFIG(1,15)=11, 2, 9,16, 0,  
JFIG(1,16)=10, 0, 0, 0, 0,  
JFIG(1,17)=12,12, 0, 9, 0,  
JFIG(1,18)=12, 9, 0, 7, 0,  
JFIG(1,19)=12, 7, 0, 4, 0,  
JFIG(1,20)=12, 4, 0, 2, 0,  
JFIG(1,21)=12, 2, 0, 1, 0,  
JFIG(1,22)=12,13, 0,13, 0,  
JFIG(1,23)=12,15, 0,15, 0,  
JFIG(1,24)=12, 0, 0, 1, 0,  
CDAT( 1, 1)= 100.00000, 518.67000, 14.69600, 0.00000, 3.00000,  
              11.00000, 100.00000, 1.00000, 66500.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 2)= 1.80000, 0.00000, 1.00000, 701.00000, 1.00000,  
              702.00000, 1.00000, 703.00000, 1.00000, 90.00000,  
              0.00000, 0.84000, 3.00000, 0.70000, 0.00000,  
CDAT( 1, 3)= 0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 4)= 1.80000, 0.01000, 1.00000, 701.00000, 1.00000,  
              702.00000, 1.00000, 703.00000, 1.00000, 90.00000,  
              0.00000, 0.84000, 5.00000, 0.70000, 0.00000,  
CDAT( 1, 5)= 0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.03000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 6)= 0.00000, 0.00000, 0.00000, 3500.00000, 0.99000,  
              18500.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 7)= 3.00000, 1.00000, 1.00000, 121.00000, 1.00000,  
              122.00000, 1.00000, 1.00000, 0.50000, 63.00000,  
              0.90000, 100.00000, 1.00000, 0.00000, 0.00000,  
CDAT( 1, 8)= 0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1, 9)= 3.00000, 1.00000, 1.00000, 121.00000, 1.00000,  
              122.00000, 1.00000, 1.00000, 0.50000, 63.00000,  
              0.90000, 100.00000, 1.00000, 0.00000, 0.00000,  
CDAT( 1,10)= 0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
              0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
CDAT( 1,11)= 0.04000, 0.00000, 0.00000, 0.00000, 0.00000,

```

          0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,12)= 600.00000,    0.99000,    0.00000,    0.00000,    0.99000,
              1.00000,    1.00000,    0.00000,    1.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,13)= 1.00000,    1.00000,    1.00000,    1.00000,    1.00000,
              1.00000,    1.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,14)= 0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,15)= 1.00000,    1.00000,    1.00000,    1.00000,    1.00000,
              1.00000,    1.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,16)= 0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,17)= 0.00000,    0.00000,    0.00000,    1.00000,    0.00000,
              8.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,18)= 0.00000,    0.00000,    0.00000,    1.00000,    0.00000,
              8.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,19)= 0.00000,    0.00000,    0.00000,    1.00000,    0.00000,
              8.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,20)= 0.00000,    0.00000,    0.00000,    1.00000,    0.00000,
              8.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,21)= 0.00000,    0.00000,    0.00000,    1.00000,    0.00000,
              8.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,22)= 0.00000,    0.00000,    0.00000,    1.00000,    0.00000,
              18.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,23)= 0.00000,    0.00000,    0.00000,    1.00000,    0.00000,
              18.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
CDAT( 1,24)= 1.00000,    0.00000,    0.00000,    1.00000,    10000.00000,
              21.00000,    0.00000,    0.00000,    0.00000,    0.00000,
              0.00000,    0.00000,    0.00000,    0.00000,    0.00000,
WMAX= 327.000,
TIT= 3500.0,
JCB= 6,
JN1=12,
JN2= 0,
JCAB(1)=11,
TITLE=1., &END
Dual-Rotor Turbojet
      111 Maximum Referred Flow Schedule (max THET corresponds to Mach = 8)
Z     1     0.00000
ALT   1     0.0
THET  41    1.00000  1.00399  1.01587  1.03537  1.06207  1.09545  1.13490
THET  41    1.17983  1.22963  1.28374  1.34164  1.40285  1.46697  1.53362
THET  41    1.60250  1.67332  1.74585  1.81989  1.89526  1.97180  2.04939
THET  41    2.12791  2.20726  2.28736  2.36812  2.44949  2.53140  2.61381
THET  41    2.69666  2.77993  2.86356  2.94754  3.03183  3.11641  3.20125
THET  41    3.28633  3.37165  3.45717  3.54288  3.62877  3.71483
WMAX 41    1.00000  1.00000  1.00000  1.00000  1.00000  1.00000  1.00000
WMAX 41    1.00000  1.00000  1.00000  1.00000  1.00000  1.00000  1.00000
WMAX 41    1.00000  1.00000  1.00000  1.00000  1.00000  1.00000  1.00000
WMAX 41    1.00000  1.00000  1.00000  1.00000  1.00000  1.00000  1.00000
WMAX 41    1.00000  1.00000  1.00000  1.00000  1.00000  1.00000  1.00000
EOT

```

```

*****
* The remaining tables were removed - see sample problem 1 for the *
* remainder of the table data listing                                *
*****

```

## 1 Dual-Rotor Turbojet

CONFIGURATION DATA 16 STATIONS 24 COMPONENTS

COMPONENT NUMBER	NKIND	COMPONENT TYPE	UPSTREAM STATIONS	DOWNTREAM STATIONS
1	1	INLET	1	0 2 0
2	4	COMPRESR	2	0 3 14
3	2	DUCT B	3	0 4 0
4	4	COMPRESR	4	0 5 15
5	2	DUCT B	5	0 6 16
6	2	DUCT B	6	0 7 0
7	5	TURBINE	7	16 8 0
8	2	DUCT B	8	15 9 0
9	5	TURBINE	9	15 10 0
10	2	DUCT B	10	0 11 0
11	2	DUCT B	11	0 12 0
12	9	NOZZLE	12	0 13 0
13	11	SHAFT	4	7 14 0
14	10	LOAD	0	0 0 0
15	11	SHAFT	2	9 16 0
16	10	LOAD	0	0 0 0
17	12	CONTROL	12	0 9 0
18	12	CONTROL	9	0 7 0
19	12	CONTROL	7	0 4 0
20	12	CONTROL	4	0 2 0
21	12	CONTROL	2	0 1 0
22	12	CONTROL	13	0 13 0
23	12	CONTROL	15	0 15 0
24	12	CONTROL	0	0 1 0

## CONTROL INFORMATION

```

17 VARY CDAT 1 OF COMPONENT 9 SO THAT STATP 8 OF FLOW STATION 12 EQUALS 0.00000E+00
18 VARY CDAT 1 OF COMPONENT 7 SO THAT STATP 8 OF FLOW STATION 9 EQUALS 0.00000E+00
19 VARY CDAT 1 OF COMPONENT 4 SO THAT STATP 8 OF FLOW STATION 7 EQUALS 0.00000E+00
20 VARY CDAT 1 OF COMPONENT 2 SO THAT STATP 8 OF FLOW STATION 4 EQUALS 0.00000E+00
21 VARY CDAT 1 OF COMPONENT 1 SO THAT STATP 8 OF FLOW STATION 2 EQUALS 0.00000E+00
24 VARY CDAT 1 OF COMPONENT 1 SO THAT NET JET THRUST (LBS) EQUALS 0.10000E+05
22 VARY CDAT 1 OF COMPONENT 13 SO THAT DATOUT 8 OF COMPONENT 13 EQUALS 0.00000E+00
23 VARY CDAT 1 OF COMPONENT 15 SO THAT DATOUT 8 OF COMPONENT 15 EQUALS 0.00000E+00

```

1 Dual-Rotor Turbojet

## DESIGN POINT MODE

```

CDAT( 1,1-8 ) 0.19709E+03 0.51867E+03 0.76885E+00 0.00000E+00 0.30000E+01 0.11000E+02 0.10000E+03 0.10000E+01
CDAT( 1,9-15) 0.66500E+05 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 2,1-8 ) 0.18000E+01 0.00000E+00 0.98844E+00 0.70100E+03 0.59176E+01 0.70200E+03 0.98882E+00 0.70300E+03
CDAT( 2,9-15) 0.39811E+00 0.90000E+02 0.00000E+00 0.84000E+00 0.30000E+01 0.70000E+00 0.00000E+00
CDAT( 3,1-8 ) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 3,9-15) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 4,1-8 ) 0.18000E+01 0.10000E-01 0.83407E+00 0.70100E+03 0.23376E+01 0.70200E+03 0.98882E+00 0.70300E+03
CDAT( 4,9-15) 0.79623E+00 0.90000E+02 0.00000E+00 0.84000E+00 0.50000E+01 0.70000E+00 0.00000E+00
CDAT( 5,1-8 ) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 5,9-15) 0.30000E-01 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 6,1-8 ) 0.00000E+00 0.00000E+00 0.00000E+00 0.35000E+04 0.99000E+00 0.18500E+05 0.00000E+00 0.00000E+00
CDAT( 6,9-15) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 7,1-8 ) 0.30000E+01 0.10000E+01 0.38496E-02 0.12100E+03 0.77563E+00 0.12200E+03 0.99778E+00 0.14008E+01
CDAT( 7,9-15) 0.50000E+00 0.63000E+02 0.90000E+00 0.10000E+03 0.10000E+01 0.00000E+00 0.00000E+00
CDAT( 8,1-8 ) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 8,9-15) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT( 9,1-8 ) 0.30000E+01 0.10000E+01 0.44098E-02 0.12100E+03 0.26521E+01 0.12200E+03 0.99778E+00 0.54514E+00
CDAT( 9,9-15) 0.50000E+00 0.63000E+02 0.90000E+00 0.10000E+03 0.10000E+01 0.00000E+00 0.00000E+00
CDAT(10,1-8 ) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT(10,9-15) 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00
CDAT(11,1-8 ) 0.00000E+00 0.00000E+00 0.99294E-06 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00 0.00000E+00

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CDAT(11,9-15)	0.00000E+00							
CDAT(12,1-8 )	0.40639E+03	0.99000E+00	0.00000E+00	0.00000E+00	0.99000E+00	0.10000E+01	0.10000E+01	0.00000E+00
CDAT(12,9-15)	0.10000E+01	0.00000E+00						
CDAT(13,1-8 )	0.10000E+01	0.10000E+00						
CDAT(13,9-15)	0.00000E+00							
CDAT(14,1-8 )	0.00000E+00							
CDAT(14,9-15)	0.00000E+00							
CDAT(15,1-8 )	0.10000E+01	0.10000E+00						
CDAT(15,9-15)	0.00000E+00							
CDAT(16,1-8 )	0.00000E+00							
CDAT(16,9-15)	0.00000E+00							
CDAT(17,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(17,9-15)	0.00000E+00							
CDAT(18,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(18,9-15)	0.00000E+00							
CDAT(19,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(19,9-15)	0.00000E+00							
CDAT(20,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(20,9-15)	0.00000E+00							
CDAT(21,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.80000E+01	0.00000E+00	0.00000E+00
CDAT(21,9-15)	0.00000E+00							
CDAT(22,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(22,9-15)	0.00000E+00							
CDAT(23,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.00000E+00	0.18000E+02	0.00000E+00	0.00000E+00
CDAT(23,9-15)	0.00000E+00							
CDAT(24,1-8 )	0.10000E+01	0.00000E+00	0.00000E+00	0.10000E+01	0.10000E+05	0.21000E+02	0.00000E+00	0.00000E+00
CDAT(24,9-15)	0.00000E+00							

1 Dual-Rotor Turbojet

#### STATION PROPERTY OUTPUT DATA

FLOW STATION	WEIGHT FLOW	TOTAL PRESSURE	TOTAL TEMPERATURE	FUEL/AIR RATIO	REFERRED FLOW	MACH NUMBER	STATIC	INTERFACE	RELATIVE
							STATP1	STATP2	STATP3
1	0.19709E+03	0.76885E+00	0.39034E+03	0.00000E+00	0.32681E+04	0.30000E+01	0.00000E+00	0.00000E+00	0.00000E+00
2	0.19709E+03	0.25364E+02	0.10834E+04	0.00000E+00	0.16504E+03	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.19709E+03	0.76091E+02	0.15216E+04	0.00000E+00	0.65196E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.19709E+03	0.76091E+02	0.15216E+04	0.00000E+00	0.65196E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.19511E+03	0.38046E+03	0.24148E+04	0.00000E+00	0.16262E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	0.18926E+03	0.38046E+03	0.24148E+04	0.00000E+00	0.15775E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	0.19299E+03	0.38046E+03	0.35000E+04	0.19712E-01	0.19365E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	0.19885E+03	0.10008E+03	0.26672E+04	0.19121E-01	0.66214E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
9	0.19885E+03	0.10008E+03	0.26672E+04	0.19121E-01	0.66214E+02	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
10	0.20082E+03	0.47879E+02	0.22899E+04	0.18930E-01	0.12952E+03	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
11	0.20082E+03	0.47879E+02	0.22899E+04	0.18930E-01	0.12952E+03	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
12	0.20082E+03	0.45964E+02	0.22899E+04	0.18930E-01	0.13491E+03	0.10000E+01	0.24953E+02	0.00000E+00	0.00000E+00
13	0.20082E+03	0.45964E+02	0.22899E+04	0.18930E-01	0.13491E+03	0.32267E+01	0.76885E+00	0.00000E+00	0.00000E+00
14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
15	0.19709E+01	0.38046E+03	0.24148E+04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
16	0.58534E+01	0.00000E+00	0.24148E+04	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

#### COMPONENT OUTPUT DATA

COMPONENT NO.	TYPE	DATOUT1	DATOUT2	DATOUT3	DATOUT4	DATOUT5	DATOUT6	DATOUT7	DATOUT8	DATOUT9
1	INLET	0.17799E+05	0.29056E+04	0.69750E+03	0.27756E+01	0.36927E+02	0.30000E+01	0.89337E+00	0.20888E+01	0.66500E+05
2	COMPRESR	-0.31527E+05	0.10000E+01	0.90000E+02	0.18000E+01	0.98844E+00	0.70000E+00	0.59176E+01	0.84000E+00	0.30000E+01
3	DUCT B	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	COMPRESR	-0.68765E+05	0.10000E+01	0.90000E+02	0.18000E+01	0.83407E+00	0.70000E+00	0.23376E+01	0.84000E+00	0.50000E+01
5	DUCT B	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	DUCT B	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	TURBINE	0.68765E+05	0.10000E+01	0.63000E+02	0.30000E+01	0.34847E+04	0.10000E+03	0.77563E+00	0.90000E+00	0.38015E+01
8	DUCT B	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
9	TURBINE	0.31527E+05	0.10000E+01	0.63000E+02	0.30000E+01	0.26660E+04	0.10000E+03	0.26521E+01	0.90000E+00	0.20903E+01
10	DUCT B	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
11	DUCT B	0.00000E+00	0.40000E-01	0.00000E+00						
12	NOZZLE	0.27799E+05	0.445538E+04	0.59782E+02	0.44998E+04	0.40639E+03	0.99000E+00	0.99000E+00	0.00000E+00	0.59782E+02
13	SHAFT	0.00000E+00	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
14	LOAD	0.00000E+00	0.10000E+01	0.00000E+00						
15	SHAFT	0.00000E+00	0.10000E+01	0.10000E+01	0.10000E+01	0.10000E+01	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
16	LOAD	0.00000E+00	0.10000E+01	0.00000E+00						

PERFORMANCE OUTPUTS

(1) NET JET THRUST (LBS)	10000.00	(2) NET BRAKE SHP	0.00	(3) AIRFLOW (LB/SEC)	197.09
(4) TSFC (LB/HR/LB)	1.3431	(5) BSFC (LB/HR/HP)	0.0000	(6) FUEL FLOW (LB/HR)	13430.85
(7) NET THRUST/AIRFLOW	50.74	(8) NET BSHP/AIRFLOW	0.00	(9) INLET DRAG (LBS)	17798.58

16 ITERATIONS 40 PASSES

1 Dual-Rotor Turbojet

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
IPRINT=0,
IDESN=0,
FIGSET=0.,
CDAT( 1,17)= 0.00000, 0.00000, 0.00000, 1.00000, 0.00000,
               8.00000, 0.00000, 0.00000, 0.00000, 0.00000,
               0.00000, 0.00000, 0.00000, 0.00000, 0.00000,
CDAT( 1,24)= 0.00000, 0.00000, 0.00000, 1.00000, 10000.00000,
               21.00000, 0.00000, 0.00000, 0.00000, 0.00000,
               0.00000, 0.00000, 0.00000, 0.00000, 0.00000,
WMAX= 327.000,
TIT= 3100.00,
JCB= 6,
JN1=12,
JN2= 0,
JCAB(1)=11,
PUNCH0=0.,
ALT= 40000.00,
NM= 1,
XMA(1)= 1.600,
NP=1,
TDEL(1)= 0.000,
TITLE=1., &END
Dual-Rotor Turbojet
```

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
40000.	1.600	16523.	0.	17625.	1.067	324.4	0.000	3100.	0.	0.000	0.	2014.	19.43	387.	0.960	12	3772.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 0.00,
NM= 1,
XMA(1)= 0.000,
NP=4,
TDEL(1)= 100.000, 100.000, 100.000,
TIT= 3000.00,
TITLE=1., &
Dual-Rotor Turbojet
```

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.000	27059.	0.	20757.	0.767	327.2	0.000	2800.	0.	0.000	0.	1807.	4.60	381.	0.941	10	2778.	
0.	0.000	24875.	0.	18667.	0.750	315.2	0.000	2700.	0.	0.000	0.	1730.	4.22	391.	0.941	4	2652.	
0.	0.000	22709.	0.	16666.	0.734	300.9	0.000	2600.	0.	0.000	0.	1660.	3.92	393.	0.941	3	2539.	
0.	0.000	20585.	0.	14772.	0.718	286.0	0.000	2500.	0.	0.000	0.	1590.	3.64	393.	0.941	3	2425.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

```
&D
ALT= 0.00,
NM= 1,
XMA(1)= 0.500,
NP=4,
TDEL(1)= 100.000, 100.000, 100.000,
TIT= 3000.00,
TITLE=1., &
Dual-Rotor Turbojet
```

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.500	28263.	0.	26059.	0.922	327.1	0.000	2924.	0.	0.000	0.	1895.	5.59	382.	0.964	1	2990.	
0.	0.500	25890.	0.	23535.	0.909	315.8	0.000	2824.	0.	0.000	0.	1817.	5.15	391.	0.964	4	2867.	
0.	0.500	23562.	0.	21103.	0.896	301.9	0.000	2724.	0.	0.000	0.	1746.	4.79	393.	0.964	3	2759.	

0. 0.500 21316. 0. 18820. 0.883 287.9 0.000 2624. 0. 0.000 0. 1677. 4.46 394. 0.964 3 2650.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 19350.52,  
NM= 1,  
XMA(1)= 1.000,  
NP=4,  
TDEL(1)= 100.000, 100.000, 100.000,  
TIT= 3100.00,  
TITLE=1., &  
Dual-Rotor Turbojet

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
19351.	1.000	19636.	0.	19506.	0.993	327.1	0.000	2900.	0.	0.000	0.	1877.	8.91	382.	0.963	9	3263.	
19351.	1.000	17928.	0.	17598.	0.982	315.5	0.000	2800.	0.	0.000	0.	1800.	8.20	391.	0.963	8	3145.	
19351.	1.000	16233.	0.	15762.	0.971	301.5	0.000	2700.	0.	0.000	0.	1729.	7.63	393.	0.963	5	3039.	
19351.	1.000	14652.	0.	14047.	0.959	287.3	0.000	2600.	0.	0.000	0.	1660.	7.10	393.	0.963	3	2934.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 37438.03,  
NM= 1,  
XMA(1)= 1.500,  
NP=4,  
TDEL(1)= 100.000, 100.000, 100.000,  
TIT= 3200.00,  
TITLE=1., &  
Dual-Rotor Turbojet

1 Dual-Rotor Turbojet

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
37438.	1.500	16495.	0.	17225.	1.044	326.9	0.000	3020.	0.	0.000	0.	1961.	17.19	383.	0.960	1	3666.	
37438.	1.500	15083.	0.	15584.	1.033	315.5	0.000	2920.	0.	0.000	0.	1884.	15.84	392.	0.960	8	3552.	
37438.	1.500	13726.	0.	14019.	1.021	302.0	0.000	2820.	0.	0.000	0.	1813.	14.79	393.	0.960	16	3451.	
37438.	1.500	12421.	0.	12553.	1.011	288.5	0.000	2720.	0.	0.000	0.	1743.	13.80	394.	0.960	3	3349.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 49458.87,  
NM= 1,  
XMA(1)= 2.000,  
NP=4,  
TDEL(1)= 100.000, 100.000, 100.000,  
TIT= 3500.00,  
TITLE=1., &  
Dual-Rotor Turbojet

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
49459.	2.000	17710.	0.	20664.	1.167	312.3	0.000	3500.	0.	0.000	0.	2292.	32.68	395.	0.947	2	4258.	
49459.	2.000	16357.	0.	18898.	1.155	301.1	0.000	3400.	0.	0.000	0.	2220.	30.87	396.	0.947	6	4164.	
49459.	2.000	15055.	0.	17226.	1.144	289.8	0.000	3300.	0.	0.000	0.	2150.	29.14	396.	0.947	3	4070.	
49459.	2.000	13717.	0.	15560.	1.134	277.0	0.000	3200.	0.	0.000	0.	2079.	27.30	397.	0.947	3	3972.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 58792.50,  
NM= 1,  
XMA(1)= 2.500,  
NP=4,  
TDEL(1)= 100.000, 100.000, 100.000,  
TIT= 3500.00,  
TITLE=1., &  
Dual-Rotor Turbojet

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
58793.	2.500	13790.	0.	17091.	1.239	234.5	0.000	3500.	0.	0.000	0.	2290.	46.26	400.	0.926	6	4377.	
58793.	2.500	12435.	0.	15332.	1.233	222.9	0.000	3400.	0.	0.000	0.	2220.	43.16	400.	0.926	2	4280.	
58793.	2.500	11141.	0.	13673.	1.227	211.0	0.000	3300.	0.	0.000	0.	2149.	40.10	401.	0.926	3	4180.	
58793.	2.500	9888.	0.	12097.	1.223	198.9	0.000	3200.	0.	0.000	0.	2079.	37.03	402.	0.926	2	4079.	

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 66561.08,  
 NM= 1,  
 XMA(1)= 3.000,  
 NP=4,  
 TDEL(1)= 100.000, 100.000, 100.000,  
 TIT= 3500.00,  
 TITLE=1., &  
 Dual-Rotor Turbojet

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
66561.	3.000	9970.		0.	13389.	1.343	165.0	0.000	3500.	0.	0.000	0.	2290.	59.77	406.	0.893	5	4454.
66561.	3.000	8809.		0.	11843.	1.344	156.0	0.000	3400.	0.	0.000	0.	2220.	55.37	407.	0.893	2	4355.
66561.	3.000	7742.		0.	10433.	1.348	147.4	0.000	3300.	0.	0.000	0.	2150.	51.25	408.	0.893	2	4256.
66561.	3.000	6765.		0.	9152.	1.353	139.2	0.000	3200.	0.	0.000	0.	2081.	47.40	409.	0.893	2	4156.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 IPRINT=0,  
 IDESN=0,  
 FIGSET=0.,  
 CDAT( 1,11)= 0.06000, 0.00000,  
 CDAT( 4,11)= 4000.00000, 0.80000, 18500.00000,  
 CDAT( 8,11)= 0.00000, 0.00000, 0.00000, 0.00000, 0.00000,  
 WMAX= 327.000,  
 TIT= 3100.00,  
 JC9= 6,  
 JN1=12,  
 JN2= 0,  
 JCAB(1)=11,  
 PUNCH=0.,  
 ALT= 40000.00,  
 NM= 1,  
 XMA(1)= 1.600,  
 NP=1,  
 TDEL(1)= 0.000,  
 TITLE=1., &END  
 Dual-Rotor Turbojet... Afterburner On

1 Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
40000.	1.600	30618.		0.	59914.	1.957	324.4	0.000	3100.	0.	0.000	0.	4000.	18.20	622.	0.960	16	5427.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.000,  
 NP=4,  
 TDEL(1)= 200.000, 200.000, 200.000,  
 TIT= 3000.00,  
 CDAT( 4,11)= 4000.00000  
 TITLE=1., &  
 Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF	FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.000	42384.		0.	82220.	1.940	327.2	0.000	2800.	0.	0.000	0.	4000.	4.31	652.	0.941	10	4127.
0.	0.000	41037.		0.	75547.	1.841	327.2	0.000	2800.	0.	0.000	0.	3800.	4.31	631.	0.941	10	4018.
0.	0.000	39681.		0.	69112.	1.742	327.2	0.000	2800.	0.	0.000	0.	3600.	4.31	610.	0.941	10	3907.
0.	0.000	38313.		0.	62904.	1.642	327.2	0.000	2800.	0.	0.000	0.	3400.	4.31	588.	0.941	10	3792.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
 ALT= 0.00,  
 NM= 1,  
 XMA(1)= 0.500,  
 NP=4,  
 TDEL(1)= 200.000, 200.000, 200.000,  
 TIT= 3000.00,  
 CDAT( 4,11)= 4000.00000  
 TITLE=1., &

Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
0.	0.500	46684.	0.	96490.	2.067	327.1	0.000	2924.	0.	0.000	0.	4000.	5.25	636.	0.964	1	4353.
0.	0.500	44990.	0.	88586.	1.969	327.1	0.000	2924.	0.	0.000	0.	3800.	5.25	615.	0.964	1	4238.
0.	0.500	43285.	0.	80964.	1.870	327.1	0.000	2924.	0.	0.000	0.	3600.	5.25	594.	0.964	1	4119.
0.	0.500	41569.	0.	73612.	1.771	327.1	0.000	2924.	0.	0.000	0.	3400.	5.25	574.	0.964	1	3998.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 19350.52,  
NM= 1,  
XMA(1)= 1.000,  
NP=4,  
TDEL(1)= 200.000, 200.000, 200.000,  
TIT= 3100.00,  
CDAT( 4,11)= 4000.00000  
TITLE=1., &  
Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
19351.	1.000	35490.	0.	73198.	2.062	327.1	0.000	2900.	0.	0.000	0.	4000.	8.36	639.	0.963	9	4818.
19351.	1.000	34055.	0.	67213.	1.974	327.1	0.000	2900.	0.	0.000	0.	3800.	8.36	618.	0.963	9	4689.
19351.	1.000	32613.	0.	61442.	1.884	327.1	0.000	2900.	0.	0.000	0.	3600.	8.36	598.	0.963	9	4556.
19351.	1.000	31159.	0.	55875.	1.793	327.1	0.000	2900.	0.	0.000	0.	3400.	8.36	577.	0.963	9	4420.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 37438.03,  
NM= 1,  
XMA(1)= 1.500,  
NP=4,  
TDEL(1)= 200.000, 200.000, 200.000,  
TIT= 3200.00,  
CDAT( 4,11)= 4000.00000  
TITLE=1., &  
Dual-Rotor Turbojet... Afterburner On

1 Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
37438.	1.500	30828.	0.	60703.	1.969	326.8	0.000	3020.	0.	0.000	0.	4000.	16.11	625.	0.960	2	5343.
37438.	1.500	29473.	0.	55694.	1.890	326.8	0.000	3020.	0.	0.000	0.	3800.	16.11	605.	0.960	2	5197.
37438.	1.500	28111.	0.	50864.	1.809	326.8	0.000	3020.	0.	0.000	0.	3600.	16.11	585.	0.960	2	5047.
37438.	1.500	26741.	0.	46205.	1.728	326.8	0.000	3020.	0.	0.000	0.	3400.	16.11	564.	0.960	2	4894.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 49458.87,  
NM= 1,  
XMA(1)= 2.000,  
NP=4,  
TDEL(1)= 200.000, 200.000, 200.000,  
TIT= 3500.00,  
CDAT( 4,11)= 4000.00000  
TITLE=1., &  
Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
49459.	2.000	30706.	0.	58288.	1.898	312.3	0.000	3500.	0.	0.000	0.	4000.	30.64	590.	0.947	2	5747.
49459.	2.000	29214.	0.	53262.	1.823	312.3	0.000	3500.	0.	0.000	0.	3800.	30.64	571.	0.947	2	5587.
49459.	2.000	27717.	0.	48415.	1.747	312.3	0.000	3500.	0.	0.000	0.	3600.	30.64	551.	0.947	2	5423.
49459.	2.000	26209.	0.	43739.	1.669	312.3	0.000	3500.	0.	0.000	0.	3400.	30.64	532.	0.947	2	5255.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 58792.50,  
NM= 1,  
XMA(1)= 2.500,  
NP=4,  
TDEL(1)= 200.000, 200.000, 200.000,  
TIT= 3500.00,  
CDAT( 4,11)= 4000.00000

TITLE=1., &  
Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
58793.	2.500	26224.	0.	51525.	1.965	234.5	0.000	3500.	0.	0.000	0.	4000.	43.37	597.	0.926	6	5931.
58793.	2.500	24800.	0.	46929.	1.892	234.5	0.000	3500.	0.	0.000	0.	3800.	43.37	578.	0.926	6	5764.
58793.	2.500	23370.	0.	42497.	1.818	234.5	0.000	3500.	0.	0.000	0.	3600.	43.37	559.	0.926	6	5593.
58793.	2.500	21931.	0.	38222.	1.743	234.5	0.000	3500.	0.	0.000	0.	3400.	43.37	539.	0.926	6	5418.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D  
ALT= 66561.08,  
NM= 1,  
XMA(1)= 3.000,  
NP=4,  
TDEL(1)= 200.000, 200.000, 200.000,  
TIT= 3500.00,  
CDAT( 4,11)= 4000.00000  
TITLE=1., &  
Dual-Rotor Turbojet... Afterburner On

ALTITUDE	MACH	FN	BSHP	WF	TSFC	REF FLOW	BPR	BOT	T19	PR19	A19	T9	PR9	A9	RR	NIT	V9
66561.	3.000	21523.	0.	44418.	2.064	165.0	0.000	3500.	0.	0.000	0.	4000.	56.04	607.	0.893	5	6050.
66561.	3.000	20200.	0.	40279.	1.994	165.0	0.000	3500.	0.	0.000	0.	3800.	56.04	587.	0.893	5	5878.
66561.	3.000	18871.	0.	36286.	1.923	165.0	0.000	3500.	0.	0.000	0.	3600.	56.04	568.	0.893	5	5703.
66561.	3.000	17537.	0.	32435.	1.850	165.0	0.000	3500.	0.	0.000	0.	3400.	56.04	548.	0.893	5	5524.

NAMELIST INPUT CARDS FOR NEXT SOLUTION

&D ENDRUN=1 &END

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## Report Documentation Page

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16. Abstract <p>QNEP is a reliable, easy-to-use computer program for predicting the design point and off-design steady-state performance for a variety of air-breathing aircraft engines. QNEP, a modified version of the Navy Engine Performance Computer Program (NEPCOMP), can be run on a personal computer with 640 kilobytes of memory. QNEP reliably computes performance parameters that agree with existing data for a variety of engines. A companion preprocessor program called QDATGEN is used to interactively generate input files. QDATGEN contains a data base of seven configurations, including two unducted turbofans, two ducted turbofans, two turbojets, and a ramjet. The user can also enter a new configuration or modify an existing configuration. The small size of QNEP should appeal to a wide range of users, including small companies or research organizations and especially students. It has the potential to be directly linked to other computer programs (e.g., mission, weight, cost, or noise analyses) that require propulsion performance data or aircraft engine thermodynamic cycle data. This report gives a detailed description of QNEP, including its input, accuracy, reliability, and limitations. It also contains a description of QDATGEN, sample calculations, and a users guide.</p>			
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